THE INDIAN PROBLEM SOLVED.

UNDEVELOPED WEALTH IN INDIA

AND

STATE REPRODUCTIVE WORKS.

THE WAYS TO PREVENT FAMINES AND ADVANCE THE MATERIAL PROGRESS OF INDIA.

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PREFACE.

No subject can be more important than the material progress and the happiness of two hundred and fifty millions of people under the English rule in India. No single person, however high his abilities may be, can do full justice to it, as it divides itself into so many important branches. Therefore each branch of the subject is treated by those most competent to deal with it. In this manner nearly a hundred most eminent authorities have been brought forward to give their evidence in language which cannot be mistaken. But all along it has been kept steadily in mind that every question has its two sides. Unless the two sides are seen, studied, and well balanced, no right conclusion can be arrived at.

We begin our work by taking a rapid glance at the effects of famines that have ravaged India during the last few years. Then we pause to inquire what are the causes of these famines? Can famines be prevented in India? This inquiry takes us to the character of the climate in India, the rainfall, and its connection with agriculture. This connection is so intimate, not only in the interest of agriculture, but also of State revenue from land, and also showing clearly why in almost every district in India, either artificial irrigation or embankments, or some regulation of the waters is required, that special papers are devoted to each subdivision of the subject. At the same time we note, in times gone by, what the Native Governments did according to the knowledge and civilisation which then prevailed in giving India's thirsty land water.

As we proceed onwards with our inquiry, we find famines in India have been actually prevented in districts where works of irrigation and navigation have been constructed. In like manner, instead of a few districts, almost every district in India, in all more than two hundred, and each as large as England, may be treated, and famine actually prevented. We all know prevention is better than cure. But our surprise and astonish-

ment is great when we find that under the English Government in past years, and even up to the present time, the noble and Christian work of preventing famines has made no satisfactory progress. If gone on at all, so slowly, so negligently—that for the want of such works, not thousands, but millions of human beings have perished from time to time in mute silence from unnatural deaths; and that agricultural produce, to the extent of millions sterling, had been destroyed, not once, but repeatedly. It is only when such awful calamities prevail, that the attention of Government is drawn to works of irrigation, and the fact to this day is, that more labourers have been employed in famine times on such works, than at any other period. Works of irrigation have been executed, in portions, bit by bit, during the prevalence of famines, as famine relief works, causing a great waste of time, labour, and money. Unfortunately this fact has been entirely lost sight of by some members of Parliament, in discussing the financial effects of irrigation works. In these pages, it is shown on very clear evidence that the returns from irrigation works are satisfactory, much more so than any other public works in India. We approach, then, the main question—the most important of all other questions in relation to the construction of reproductive public works in India.

What has been England's policy in India as regards such public works, and what that policy should be? Speaking in round figures, which will answer for our illustration, we find that the State in India has spent up to the year 1872 £100,000,000 sterling in making 5,500 miles of railway, £10,000,000 in about ten years for providing improved accommodation for 14,000 European troops; £3,000,000 in constructing transport vessels to carry backwarks and forwards troops to India, including an iron floating dock to repair these vessels; £10,000,000 on irrigation works from the time India has been conquered; £10,000,000 in erecting handsome government offices; and various sums, large and small, have been sunk as capital by the State in India, which we leave out, as not important for our illustration.

Now, taking the largest amount of outlay in India, namely, £100,000,000 sterling expended on railways, nearly half of which has been spent in England, for purchasing materials, &c., we naturally inquire what is the financial result of these railways, almost all single lines, main lines too, connecting the

metropolis of India with Bombay, Madras, and Northern India. The result is this, that the most profitable railway in India, the East India Railway, just earned on two exceptional occasions 5 per cent., being the amount of guaranteed interest Once during the American war, when cotton and other traffic vastly and suddenly increased, the second time during the famine in Bengal in 1874, when Government paid to this railway £850,000 for carrying private grain at half the usual railway charges; when Government itself entered the market, forwarded thousands of tons of food grain, and nobly spent £6,500,000 sterling in saving millions of people from starvation, for the first time in the history of India. This, the East India Railway, the most profitable in India, has a debt of £7,000,000, not including value of land given free by Government, the interest of debt, &c. In fact, there is not one single railway company which does not work its line at a loss of millions sterling. In the course of a few years the aggregate loss in working 5,500 miles of railway, after deducting nett traffic receipts, amounts to £20,000,000 sterling. The fact may appear startling and incredible that half this amount of railway loss, or only £10,000,000 sterling, has been spent on irrigation works for the prevention of famines, from the conquest of India up to the present time. The works on which £10,000,000 have been spent are there—making returns more or less—but the loss of £20,000,000 sterling already paid from India's taxes to guaranteed railway companies is gone clean for ever, to return no more. What makes the case worse, is that round India's neck the British rulers have put a yoke which exacts £2,000,000 sterling every year for enjoying the luxury of railways, not including interest of debt.

Now of all other questions relating to reproductive public works in India, this policy of making railways in a poor country requires careful reconsideration from all points of view. It is a matter of deep regret that it has not received any attention in Parliament up to this time.

Does India want railways or irrigation works? Can railways provide water for India's land, when that land is thirsty and hard baked, or provide drainage for preventing floods? Can railways produce food grains and other agricultural produce, as it is created by water from irrigation works? Can the State Land Revenue be doubled by railways as it is and can be by irrigation works? Can famines be prevented in India

to any extent to be compared with irrigation works? The answer to all these questions must be in the negative. What certainly railways can do and have done is to carry produce and passengers at twenty miles an hour. But happily we can make large irrigation canals at a very slight additional expense navigable, and even adapted for steam navigation, complete with drainage works to prevent floods, and to provide irrigation.

Combined irrigation and navigation canals have been made and can be made in India at a third or a fourth of the cost of making railways, and produce and passengers carried on water at half the railway charges or even less, as is now done on some Madras Delta works. Canals will just suit India's requirements in every respect, for the present and many years to come, and moreover will pay financially and leave no burden on Indian taxpayers, or increase India's debt. In England, very narrow canals were made for navigation before the introduction of steam. We see so much of the *éclat* of railways, are carried forward by express trains at forty miles an hour to long distances, that we are carried away altogether and believe railways are adapted for all countries. This is a mistake, and the more we study the subject the more clearly we see the mistake. From the peculiarity of the climate in India, irrigation works can create wealth in India, with all the advantages which follow the creation of wealth. In a poor country, like India, railways are a complete luxury. When she grows tolerably rich, which must take many years if we do our duty, then let us give her railways. To construct railways in her present state is, as some one put it, giving a beggar a carriage to ride, or, as a secretary to Government stated, it is giving India a stone when she cries for bread. That this is actually the case may be inferred from the fact, not mentioned in railway reports, that the short State railway lines of Oomravatte and Khangam are worked during the cotton season only for a few months, when cotton is sent down to the coast, and entirely shut up for the remainder of the year for want of traffic in goods or passengers.

If such is the case in the very heart of the country, and if the present nett loss for working the main lines amounts to £344 per mile, or £2,000,000 sterling per annum, how much that loss, *i.e.*, the burden on Indian taxpayers, will be increased by the State railways now proposed and taken in hand by the Government! The State railways are military

railways, consisting chiefly of the Punjab, Northern, and Indus Valley State railways, constructed with the object to prevent a supposed invasion of India by the Russians. The loss in working these military railways would be enormous—much more than the present loss per mile in working the main lines.

In and out of Parliament our statesmen who rule over India have repeatedly declared their resolution and their policy not to expend any borrowed money on works not likely to pay interest on the amount borrowed. Yet the Government is doing exactly the reverse; it is constructing military railways from loans, which railways the Government itself declares cannot be worked with any profit, but at a certain loss. What faith can we put in our statesmen who say one thing and do another? From those who rule over India we at least have a right to expect honesty of purpose and sincerity.

The English policy as regards reproductive works in India, though it lies at the root of all our financial difficulties in India, has hardly been discussed in Parliament yet. Some M.P.s have spoken strongly against the Public Works Department in course of the debates on the annual Indian Budget. No one will deny that the department requires a thorough reform, but, at the same time, we must not forget it is a mere machine to carry out a policy framed and sanctioned by the Secretaries of State and Governor-Generals in council.

In making railways in India our rulers have increased India's debt, and made a fatal mistake. Let us pause. Let us not persist in a policy which must increase taxation, and increase the public debt. Before we construct such costly State railways to put a stop to a supposed Russian invasian of India, let us first of all do our very best, in all good faith and sincerity, to remove India's poverty Let us first of all use our means, our knowledge, and our power to develop her resources, to increase her material prosperity, to be just and generous to the people, and to give them their due share in the government of that empire. Let us base the foundation of our rule in India in making her teeming population happy and contented. Let us carry out the spirit of the Queen's proclamation, and the solemn promises given therein, and not trample them down under our feet. A disaffected population is a discredit, and a source of weakness, not an honour or strength, to our rule in India.

LONDON, *October*, 1874.

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Blue-books, English and Indian papers, &c.

CONTENTS.

Principal Irrigation Works in India

Irrigation and Land Revenue

Canals or Railways?

Estimates and Plans of Canals.

Social and Political Effects of Canals

Capital, Labour, and Engineers for Works

Coal and Iron Mining

The Material Progress of India

AREA AND POPULATION

OF BRITISH ADMINISTRATION OR GOVERNMENT IN INDIA, EXCLUSIVE OF NATIVE STATES

Under the Administration of	Total Area in Square Miles.	Number of Districts.	Population	Population to Square Mile
The Governor-General of India—				
Ajmere	2,672	1	426,268	159
Coorg	2,000	1	168,312	84
Berar	16,960	6	2,231,565	132
Mysore	27,077	8	5,055,412	187
Governors—				
Madras	141,746	21	31,311,142	220
Bombay	127,532	23	14,042,596	110
Lieutenant-Governors—				
Bengal	248,231	58	66,856,859	269
North-West Provinces	80,901	35	30,769,056	380
Punjab	102,001	32	17,596,752	173
Chief Commissioners—				
Oude	23,973	12	11,220,747	465
Central Provinces . .	84,162	19	9,066,038	108
British Burmah . .	93,664	14	2,562,323	27
Total British Administration .	950,919	230	191,307,070	201

SOCIAL, FINANCIAL, AND POLITICAL EFFECTS OF FAMINES IN INDIA.

FAMINE IN THE NORTH-WESTERN PROVINCES IN 1860—61.

BY COLONEL BAIRD SMITH, R.E., C.B.,

ON SPECIAL DUTY.

PERIODICITY OF DROUGHTS.

OVER the whole area, and, indeed, in some instances far beyond it, famines of variable intensity have ranged within historic periods, devastating sometimes one section of it, sometimes another, but very rarely indeed involving the whole in one common intensity of suffering. The records of these remoter calamities are misty and indefinite. Traces more or less have been found of droughts from 1733, with intervals of four, six, seven, eight, ten, eleven, thirteen, and twenty-four years. Among these the most destructive were in 1770-71. The following famine and ordinary prices in Lower Bengal in 1770 confirm the general impression of the sad sufferings:—

FAMINE AND ORDINARY PRICES IN 1770.

Rice, best	per rupee	3 seers,	ordinary price	28 seers
,, coarse	,,	$3\frac{1}{4}$,,	,,	40 ,,
Inferior grains	,,	$4\frac{1}{2}$,,	,,	45 ,,
Dal (pulse)	,,	4 ,,	,,	30 ,,
Wheat	,,	$4\frac{1}{4}$,,	,,	26 ,,
Ghee, per maund		20 rupees	,,	5 rupees

The next great famine, in 1783, was of unusually large extent. The drought of 1803 seems to have been confined to the North-West Provinces. A proclamation by the Governor-General in Council, dated Fort William, 27th September, 1803, was issued

directing a bounty shall be paid on all grains per 100 maunds—at Benares, rupees 15; Allahabad, 19, Cawnpore, 23, at Futteeghur, 27: and on wheat and barley, 17, 22, 24, and 31 rupees (bounty) to encourage the importation of grain.

EFFECTS OF LAND-SETTLEMENTS ON SOCIETY.

That period of climatic disturbance which reached its maximum in the drought and famine of 1837-38, was coincident in point of time with the most vital administrative act which ever influenced the material condition of native society in the Upper Provinces. From the time of our earliest acquisition of any part of these provinces up to 1833, our fiscal system, notwithstanding some improvements on the native methods which were gradually introduced, had been thoroughly bad. The assessments were excessive, unequal, and unintelligent. Fixity of demand was virtually unknown, and, with exception to a small part of Benares, no settlements exceeded five years in duration, while a few were annual and many triennial. The collectors were, as a rule, utterly ignorant of the forms of tenure, and of the complex system of individual rights which was in lively action around them. So frightful, at length, became the confusion induced by these causes in the state of landed property, that remedies, whose very violence is a measure of the height to which the evil to be abated had risen, were of necessity adopted. A judicial dictatorship was established in 1821, and all public and private transfers of land made within the first seven or eight years after the cession were subjected to its decision. But from the inherent practical defects in the modes of procedure prescribed, and in certain other points, the plan failed in producing satisfactory results. In Futteypore only three villages have been settled between 1822 and 1833, and it was generally estimated that something like a century must pass before the whole of the provinces could be finally settled. This was, of course, equivalent to a sentence of condemnation on the score of impracticability, and if the plan had been persisted in, the famine of 1860-61 would have found us with fully three-fourths of the work still to do. Act IX. of 1833, however, transformed an unworkable into a perfectly workable scheme, by correcting its errors, simplifying its processes, limiting its range, and supplying for it a comparatively new and special native agency, highly paid and honourably placed, from which much invaluable aid was obtained.

CONNECTION OF LAND ASSESSMENT WITH FAMINES.

No misapprehension can be greater than to suppose that the settlement of the public demand on the land is only lightly or, as some say, not at all, connected with the occurrence of famines. It lies, in reality, far nearer to the root of the matter, because of its intimate and vital relation to the every-day life of the people, and to their growth towards prosperity or towards degradation. It is no doubt quite true that not the best settlement system which mortal intellect could devise would cover the skies with clouds, or moisten the earth with rain, when the course of nature had established a drought. But, given the drought and its consequences, the capacity of the people to resist their destructive influence is in direct proportion—I would almost say geometrical proportion—to the perfection of the settlement system under which they are living and growing. Speaking in general terms, therefore, native society in the north-west had to face the calamity of 1837, debilitated by a fiscal system that was oppressive and depressing in its influences; and with its agricultural population generally discontented under the extreme confusion into which, by the action of both revenue and judicial systems, all their most treasured rights had been thrown. In India, we all know very well, that, when the agricultural class is weak, the weakness of all other sections of the community is the inevitable consequence Internal trade was burdened and harassed by cumbersome duties, and carried on under difficulties of transport.

FAMINE TRACTS TWENTY THOUSAND SQUARE MILES.

The total area of the famine tract of 1860-61 may be estimated roughly at from twenty to twenty-five thousand square miles, or from twelve to sixteen millions of acres; it does not differ very materially in extent, therefore, from that of 1837-38.

An almost entire failure of the rains required for the autumn crop, and the consequent destruction of that crop, was followed by a total failure of the spring rains, so that no land could be cultivated but with the aid of artificial irrigation.

POPULATION AFFECTED EIGHT OR NINE MILLIONS.

The total population affected by the famine of 1837-38 must have been between eight and nine millions, and the population of the districts within which the intensity of suffering was greatest and the mortality highest must have been roughly

about five millions. In 1860-61 the corresponding numbers were about thirteen and five millions; but, in reference to the latter number, it will be noted that no such discrimination could be used in distinguishing the various interior areas of greatest intensity in 1837-38 as was practicable in 1860-61. During the famine of 1837-38 the average price of wheat in the worst localities may safely be taken at 12½ seers per rupee. It is well known that in the worst localities of the famine of 1860-61 the price was up to 7½ seers per rupee, and ranged between that and 8½ until the influence of the vast importations in February, March, and April, 1861, began to tell on the markets, when it fell to between 10 and 11. Making all needful allowance, there can be no question, I think, that the pressure from dearness of food ought to have been sensibly greater in 1860-61 than in 1837-38. It is unnecessary to refer to the prices of other grains than wheat during the two periods, for it is the common law of famines in this country to equalise nearly the prices of all grains fit for human food, ordinary distinctions between superior and inferior invariably disappearing to a very notable degree.

DISORGANIZATION—MORE TROOPS REQUIRED.

No sooner had the serious pressure of the famine begun to be felt in 1837-38 than the ordinary bonds of society seemed to be broken by it. Beginning in Rohilkund, the population gathered into bands for plunder, and, driven desperate by starvation, they everywhere attacked the grain-stores in the larger villages and towns, and carried off their contents. Spreading rapidly, the disorganization soon reached the districts of the Lower Doab, and deplorable confusion is described as having prevailed from Bareilly to Allahabad. Troops had to be moved out on some occasions, and during the whole course of the famine a largely augmented police force, both of horse and foot, had to be kept up to maintain the peace, a duty which, however, was very difficult to perform against large bodies of men whose natural instinct for fight or plunder was quickened by the sense of their own sufferings, and the sight of those of their wives and children.

FAMINE MORTALITY—EIGHT HUNDRED THOUSAND DEATHS.

The general mortality cannot, of course, be known now, with any approach to precision, but I doubt if it were less throughout

the entire famine tract than about *eight hundred thousand.* The poorer landholders who, in 1860-61, were just able to struggle through the time of greatest need, suffered in 1837-38 as bitterly as did the mere labourers and artisans now. Large numbers of them died of starvation, and I find it specially noted that among the 80,000 paupers employed or supported by the magistrate of Agra, a very large proportion was of small proprietors. Their land was utterly valueless unless they could cultivate it; it had no market price, for no man would buy it, or make advances upon it as security, so that their only resource was to become paupers or perish.

A PICTURE OF THE STARVING POOR.

The general condition of the population of the very bad districts, however, may be judged of from the following description by Dr. Cutcliffe, civil surgeon, of those received into the hospital of the Meerut Relief House. In speaking of their personal state, he says, "*They were one and all starving, and the majority were skeletons from atrophy.* This was not an hospital for sick only, but for starving people attacked by disease.

"That famine has been prevailing in the district is a fact patent to all. The people, sore pressed for want of natural aliment, endeavoured to support life by eating wild fruits and vegetables, procurable at the expense of toil in gathering them. They had suffered not only from simple deficiency of food, but from deficiency of digestible material; from having eaten as substitutes for proper nutriment vegetables and substances acting injuriously upon them.

"But they were not only ill nourished and poor blooded. They were also suffering from great nervous depression, both before and after admission into hospital before, from social calamities, loss of homes, of relatives, and of friends, from the dark prospects of the future and the disseverance from the ties of village life, with its freedom and petty independence; and after, from the conviction of their being enclosed in a poor-house, surrounded by suffering in every form, to-day perhaps witnessing the death of a child, and expecting to-morrow that of their wives, and only hoping that their own might soon follow. From the first to the present time the great mental depression of the sick in hospital has been most remarkable, and many instances have occurred of men who refused to take food, on the plea that they did not desire to live, either because their villages had

been in part deserted, and their families scattered, or that they had lost their children or nearest relations, or sustained in some way or other some severe trial of the affections, and had succumbed to despair. Many had wandered about the country after leaving their villages, and had been exposed to the vicissitudes of the climate, fainting under the heat of the sun by day, and shivering from the cold by night, from which indeed they were ill protected. Many people thus found were sent into hospital by the police, and some in the last stages of disease arrived only to die."

It was my duty to go from district to district. I have seen the abject wretchedness to which the people of the bad sections were reduced. Long before I read the medical report just quoted from, the aspect of deep depression, common to all the real sufferers by the famine, had struck me everywhere. I am familiar, of course, with the bearing of natives generally under suffering, and know them to be often easily borne down by it, but I have never before seen such an aspect of desolate despair as many of these men presented, all of whom, till this great calamity struck them down, had evidently been able to support themselves and their families by honest and independent toil in husbandry or otherwise

VALUE OF PRODUCE DESTROYED—MILLIONS STERLING.

The average annual land revenue of the Agra division prior to the famine was, in round numbers, nearly £750,000 In the five years following the famine it fell to £625,500, thus showing an annual loss of £124,700, or a total loss in five years of £623,500. Further, however, the lapse of five years by no means obliterated the influence of the famine on the revenue of the State. In the following five years the average annual revenue was still nearly £50,000 below the standard prior to the famine, and in those years a farther loss of nearly £250,000 took place. At this present time the revenue continues to show a difference from the above standard of about three and a half lakhs, so that about £455,000 must be added for the loss in the thirteen years intervening between 1846-47 and 1859-60. The stamp of this terrible calamity has, therefore, remained unef-faced in this division by the lapse of twenty-two years, and the State has received from the districts forming it less revenue, by an aggregate amount of the almost incredible sum of

£1,328,500, than it would have done had it been possible by any expedients to have warded off the catastrophe.

It is well that in dealing with measures to remedy calamities so disastrous, some definite conceptions should be formed of the vast interests involved, and few illustrations could be more impressive than this, which shows that *within a single division, agricultural property certainly not less that from eight to ten and a half millions sterling in gross value was entirely annihilated.* Nearly equal in order of intensity stands the Allahabad division, including the districts of Allahabad, Futteypore, Cawnpore, Humeerpore, and Banda Here the loss in the first five years following the famine was £127,000 annually, or, in all, £635,000. In the succeeding five years, however, the loss was sensibly less than in the Agra division, being £38,800 per annum, or, in all, £194,000. Its revenue is still about £20,000 per annum below the standard previous to the famine. The whole loss of revenue in this division may therefore be computed at £1,089,000, representing a *destruction of agricultural property which may be valued at from six to eight millions sterling*, according to the proportion which the revenue is assumed to bear to the gross produce of the land. Regarding this proportion opinions differ, but for purposes of calculation I take it to be as one to eight. Rohilkund shows very moderate traces of suffering. The total loss in this division did not exceed probably about £180,000, and *one million sterling* may be taken to represent the value of produce lost.

The scale of remissions of the Government revenue in aid of landed proprietors who have borne the loss of produce would indicate a loss over the entire famine track of, say, three and a quarter millions sterling, assuming the Government revenue to represent about one-eighth of the gross produce of the land.

LOSS OF FARMING CATTLE, ONE MILLION THREE HUNDRED AND FIFTY THOUSAND POUNDS.

A loss that is likely to tell more heavily on the farmers than even the temporary loss of manual labour, is the loss by death of their plough and well bullocks. In the Meerut district, it is believed that fully one-half of the farming cattle have already died, and it is known that the rate of mortality is increasing. Such a state of things implies great paralysis of work in the bad tracts, whatever the nature of the season may be, and may well cause very deep anxiety. Ordinarily, the farmer maintains

cattle for his wells and ploughs with other work, at the rate of about one pair for each four acres under cultivation; and as the section of the Meerut district, over which the drought has almost annihilated the crops, is about four-tenths of the whole, the total number of bullocks for farming purposes at the beginning of the pressure was probably about eighty thousand pairs. Of these forty thousand pairs, more or less, are reported to have gone, and of the remainder the mortality is now said to be greater than ever. Even the loss believed to have been already sustained, however, in this single district cannot be replaced, but at an outlay of £100,000. As very nearly the same general proportion of bad tracts to good runs throughout the central section districts, the loss to the agricultural community there, in cattle only, can scarcely be less, and may possibly be more, than £500,000. In the eastern section, the loss is probably much less from the large extent of forest or river valley pasturage available; but in the western section, where no such advantages exist, the mortality has been even greater than in the Doab, and the accounts I have received from the Delhi districts are truly deplorable, as the increasing losses of cattle there are described as causing extensive abandonment of villages by the people. The entire loss, therefore, from this cause is not likely to fall under £750,000.

These men, and the sufferers who still cling to their villages, have fought their fight bravely and well, and I earnestly hope that some help may be given them in such forms as will be most effectual in helping them to help themselves. Nothing could do so more effectually than aid in replacing their lost cattle, or in general help towards the resumption of their usual work, and the central relief committees could not better do their work than by coming forward to lighten this crushing burden.

COST OF RELIEF.

At about a hundred separate centres no fewer than 80,000 helpless poor have been fed. Through the agency of special works of relief about 140,000 more have been supplied with means of subsistence.

By relief houses, relief works, and employment on ordinary public works, not fewer than half a million of the population must have benefited directly. The spontaneous relief sought in emigration has influenced nearly half a million more; and if

account be taken of those tribes who have hitherto struggled on without accepting other relief than that from public demands on account of land revenue, the great body of sufferers can scarcely be less than from one and a quarter to one and a half millions.

The expenditure incurred in various forms, including among them the remissions of government revenue which have been or will be granted, falls not much short of three-fourths of a million sterling.—(Extracts from Special Report, August, 1861.)

FAMINE IN BENGAL AND ORISSA IN 1866.

BY MR. (SIR) GEORGE CAMPBELL, COL W. E. MORTON, R E., AND H. L. DAMPIER, ESQ., SPECIAL COMMISSIONERS.

ALL the records and the correspondence, official and demi-official, both of the local officers and of the Board of Revenue, have been freely placed at our disposal. We have, in fact, by local search and inquiry, obtained much that would not have been found elsewhere, and we feel tolerably confident that we are possessed of all that is very material of the correspondence existing on record. We have not hesitated to seek for and make use of demi-official letters. It was in the province of Orissa that the great calamity was felt in by far its widest extent and in its greatest intensity.

RAIN FELL, BUT OUT OF TIME.

The natural cause of the scarcity and famine may be simply stated to be the premature cessation of the rains of 1865 throughout the lower provinces of the Bengal Presidency, in the middle of September, 1865. The total quantity of the rainfall for the year was not unusually small in most of the districts of Bengal, but it fell abnormally and out of time. Much rain fell early in the season, before the usual time for sowing had arrived, and when its continuance could not be depended on, while the latter rains, which are usually expected in the end of September and October, failed. The fall of rain in Orissa is much larger than that in many parts of India, and is generally sufficient for the successful cultivation of rice (the staple food of these provinces); but it is precarious, and the yield is subject

to great variations, according to the season. The province is also extremely subject to the opposite evil of inundations The rivers are always liable to overflow to an extraordinary degree, causing more or less destruction, according to the chances of each season. The sea is also an enemy, occasionally still more destructive. The low lands are embanked against it, but great storm waves have carried everything before them, and, especially in the Balasore district, have done frightful mischief.

RISE IN WAGES NOT EQUAL TO RISE IN FOOD.

It can hardly be said that in most districts the rise in the price of labour has been equal to the rise in the price of grain. Hence, the position of the man depending solely on money wages has by no means improved, and the class represented by such a man probably felt the effect of a season of failure at least as quickly as would have been the case in times when the country was not so far advanced.

POPULATION AFFECTED, TWO AND A HALF MILLIONS.

The following is the area of the districts of the Orissa provinces:—Pooree, 2,697; Cuttack, 3,062, and Balasore, 1,890 square miles. The area of the tributary mehals is about 15,000 square miles.

Speaking very roughly, we may estimate the population of the three districts to have been before the famine above two and a half, or perhaps not far short of three, millions. As respects the population of the tributary mehals, nothing is known.

DISTRICTS DISORGANIZED BY GRAIN PLUNDER

Early in 1866 there was very extensive evidence of the existence of a poor class unable to buy, in the shape of plundering outbursts of gangs of men, in whom hunger had destroyed all respect for property. In fact, in the spring of the year this country was disorganized by grain robberies, which did not diminish till the rains and the exhaustion of men and stocks caused such violent crime to subside from inanition. The general plunder of grain, and the circumstance that in every case the plunderers were recognised, or are said to have been recognised, by the plundered as persons well known to them, sufficiently indicate the character of the crime. In Balasore also prices were not high in the extreme in the first part of the

season, but they soon became so, and the district was very early disorganized by plunder. This symptom, indeed, usually characterizes the early period of famine in India.

SCENES OF SAD DISTRESS.

The first effect of the scarcity, universally, was to drive the people to subsist on unusual and unwholesome food, jungle roots, and such like, and we find that cholera constantly accompanied want. We have it first in the districts of Southern Pooree, where excessive want first appeared, then about Pooree itself and Gope, and later in the eastern portions of Cuttack. The fact is that the tide of famine eventually surged so high all over Orissa that local inequalities may almost be said to have been submerged and lost sight of in one wide-spreading sea of calamity. Nothing is more clear than this, that though on the one hand many will not resort to relief centres for cooked food till the last extremity, on the other, the misery among the very poorest is never properly known till the offer of food brings out from their hiding-places the poorest and most miserable objects. This was very evident in other districts where relief in food was given. Balasore presented terrible famine scenes long before the district was nearly so bad as Pooree; and in Midnapore Mr. Herschel, the magistrate and collector, tells us how the existing misery was suddenly brought to his knowledge when food was offered. Mr. Ravenshaw's report (2nd May) states :—"Those who have not taken to dacoity have lapsed into the most abject state of misery and distress, having become too weak, for want of food, either to work or rob. They absolutely swarm in the station and villages, either dying of cholera, dysentery, or hunger, or picking up a bare subsistence by begging on public charity. Pinched by hunger and disease, as soon as a door for relief is opened, the rush of applicants is so great as to nearly overwhelm the persons appointed to distribute food. I went myself, and witnessed such a scene as will never be effaced from my memory."

MORTALITY, ONE-FOURTH OF THE POPULATION.

The extent of the mortality never will be ascertained with any accuracy. Mr. Ravenshaw in his report estimates it at not less than one-fourth of the population of the province. In the supplemental report he shows that in the subdivision of Kendraparah one-fourth of the people are estimated to have died

before 1st August, and the mortality consequent on emaciation and want having continued for several months subsequent to that date, and having been, in the part of the country alluded to, very considerably aggravated by floods, he indicates a more excessive proportion in particular parts. In so many parts the great mass of the proper labouring population (as distinguished from farming ryots) seems to have been really so much swept from the face of the earth, that we cannot take on ourselves to say that the estimate of one-fourth is too high, even in parts which have not suffered much from the floods of 1866.

WANT OF IRRIGATION WORKS.

The waters of the rivers had not been turned to any considerable account for purposes of irrigation, and, excepting some petty water supply obtained by the industry of the ryots of some particular sections of the country, these districts may be said to have been without any artificial irrigation whatever beyond that to be drawn in an unusual crisis of drought from natural watercourses and the petty tanks and water lodgments of the country. They depended almost solely on the supply of rain from above.

THE COAST WITHOUT ANY APPLIANCES.

The nature of the coast and the sea is such as effectually to stop all native traffic for the major part of the year. One of the rivers of Orissa (the Dhamrah) has proved to be capable of receiving vessels drawing twelve to fourteen feet of water, even at the worst season of the year, provided they enter with the aid of steam, and that the old river harbour of Balasore (very early frequented by European mariners) can similarly receive vessels drawing eight to nine feet. Steam, however, had not been available.

NO ROADS: TRAFFIC ON PACK-BULLOCKS.

The only ordinary communication with the outside world is by the route traversing its length. That, however, is so much intersected by streams, and has been hitherto so little rendered practicable by art, that it is comparatively little used by wheeled carriages; pack-bullocks still predominate at all times. In the rainy season wheeled traffic is quite impracticable, and when the rains are heavy, even pack-bullocks cannot be used. At this day the European officer who cannot obtain a special steamer

must find his way into Orissa slowly and tediously, as ancient officers may have travelled in the days of Asoka, and the very post takes several days between Calcutta and Cuttuck.

THE PEOPLE WITHOUT EDUCATION.

The people of Orissa are also separate and distinct, of a character and language peculiar to themselves. They seem to be certainly less quick and pushing than the Bengalees, and the higher classes have had much less education—it may almost be said no education; in fact, they are altogether more Bœotian.

REMEDIAL MEASURES.

We have shown how completely the greater part of Orissa is, as it were, out of the world—how inaccessible it is to ordinary trade, and with what fearful results that inaccessibility was attended. We now proceed to indicate the mode in which we think that this defect may be remedied. We may notice the town of Cuttack, being the capital of the province, and of a great district the importance of which must every day immensely increase. The trunk road from Calcutta to Cuttack, and thence onwards, is a great work, and its prosecution will be extremely useful, as connecting different parts of the districts through which it passes.

IMPROVEMENT OF HARBOURS.

The sea route by way of False Point is within thirty hours' steam of Calcutta. We have mentioned how well the anchorage is protected. The place may, without exaggeration, be said to be by far the best harbour on the whole coast of India between the Hooghly and Bombay. The depth of water, though not very great, is quite sufficient for a very large class of steamers, and there is this great advantage, that the bottom is so soft that the commanders of vessels are indifferent to running aground, although they have usually no occasion to do so. The place must, without doubt, be the harbour and outlet of the whole system of water communication which will be utilised and systematized by the canals.

RIVER COMMUNICATION.

It would be further desirable that the whole of the rivers communicating with those which debouch at False Point should be searched out by small steamers. At present they are hardly

known; but there is a congeries of rivers, and the country may be completely opened up. The steamers sent down from Calcutta at the end of the season went twenty-five miles up two different rivers, towing native boats, in November. Proper postal communication must, of course, be established, and we think that a telegraph is an altogether essential part of the scheme.

SPECIAL OFFICERS REQUIRED IN PUBLIC WORKS.

If great irrigation works must be undertaken directly by the Government, we would urge the necessity not only of forming provincial irrigation departments, but of establishing a general irrigation service for the supply of officers thoroughly instructed in and devoted to that department. The great disadvantage under which the Government public works establishments labour is, that the officers are generally not devoted to particular branches, and it may be said almost never to particular undertakings. For many reasons constant changes occur, so that it scarcely happens that any man has ever carried out to completion any great work. Above all things, it must be remembered that all substantial public works are the relief of the more or less able-bodied; that if a certain point of suffering is passed before special works are made effective for relief, they are useless.

WHY THE POOR WILL WITHSTAND A SCARCITY LESS HEREAFTER.

We have alluded to the effect of changes which, while rendering the person more free, society more advanced, and labour in one sense more independent, may also, by loosening the ties of personal inter-dependence, render the poorer classes less capable of withstanding calamities of season. We must repeat a doubt whether the labouring classes of England or France could withstand a general enhancement of the price of food to twice or thrice its ordinary price, as do the natives of India. But we must not blind ourselves to the fact that every step in advance, in the modern sense, tends to render them as dependent on daily wages as more civilised labourers. Under the purely native system almost every man is more or less a farmer, or the immediate personal dependent of a farmer who has his banker and his banker's book, and the credit which enables him to live from year to year, rather than from day to day. But all our com-

merce and our enterprise, our great works and improved systems, create or increase the class of labourers depending on regular wages, and all increase of private wealth, enabling the richer to entertain labourers who are no longer slaves or serfs, adds to the class It may be, that with the increase of general wealth, the labourer will eventually be, in ordinary times, better off than he ever was before, but that he will as well resist extraordinary seasons we do not deem probable. There is, we believe, reason to expect a gradual increase in the classes who may hardly withstand a scarcity not amounting to that extreme famine which involves the whole population. We have several times alluded to the wonderful way in which natives recognise the personal obligations of supporting their own poor. As long as any of a family, it may almost be said any of a clan, have the means of supporting their indigent relations and connections, they do so in a marvellous and admirable way. Only when calamity either reduces whole families and classes to starvation, or brings them so low that, on a principle of two on a plank, some must inevitably be sacrificed, large numbers are cast out either to die or to be saved by public charity. Experience proves that the voluntary local charity of rural districts is insufficient to meet heavy calls on it.

IMPORTATION BY GOVERNMENT OF RICE.

It seems to have been in some quarters considered that the importation of food by Government, either directly or through contractors, would have been a proceeding of an almost unprecedented character, as, in fact, one which involved the sweeping away of the established landmarks of society. Mr. J. S. Mill is quoted as follows:—"Direct measures at the cost of the State to procure food from a distance are expedient when, from peculiar reasons, the thing is not likely to be done by private speculation. In any other case they are a great error. Private traders will not, in such cases, venture to compete with the Government, and though a Government can do more than any one merchant, it cannot do nearly as much as all merchants." The exception when "from peculiar reasons the thing is not likely to be done by private speculation" seems entirely applicable to the case under discussion, and to have been entirely overlooked. In Ireland, so near all the resources of British commerce, on the very first symptoms of famine the Government seems to have imported food; and throughout the

Irish famine administrations, composed from either side of politics, appear to have largely undertaken the supply of food to the starving people. It is, we think, by applying general principles, without regard to local circumstances, that error arises in such matters. If only as an employer of labour in Orissa, we think that Government would have been justified in taking the most effectual means of paying that labour in the shape most effective for the object in view.—(Extracts from Report, dated Calcutta, 16 April, 1867.)

LORD LAWRENCE'S MINUTE ON ORISSA FAMINE.

I concur in the view of the Commission that timely measures were not taken to meet the evil, when famine threatened the country, nor indeed when it had become, I may say, certain; and I think with them, that valid reasons cannot be adduced for this neglect It seems to me beyond all doubt that there was a want of foresight, perception, and precaution regarding the impending calamity. His Honour had quite enough before him to show that there was at least much danger of the occurrence of such a calamity. But at any rate the very clamour from the starving multitude, which beset him when at Pooree, ought to have led him to make especial inquiry, which could not have failed to lay bare the real condition of the people at that very time. It was certainly the duty of the Lieutenant-Governor to have done this.

Again, it appears to me quite impossible to acquit the Board of Revenue of serious errors in their management of affairs in Orissa from the very commencement of the crisis even to the end. The members of the Board at the outset set their faces against the wish of the officers of districts to go about and to ascertain the real state of things, and the actual out-turn of the harvest, under the delusion that inquiry was useless, and even pernicious, unless followed by remission of revenue, which they had determined not to grant or recommend.

Notwithstanding the extraordinary emergency of the crisis, only one steamer was for some time employed on the coast of Orissa, and yet it is clear from Captain Howe's evidence that other steamers might have been hired had orders for the purpose been issued.

Further, it appears that the unfortunate order whereby money and not grain was to be paid to the labourers employed on the famine relief works emanated from the Board, and was

maintained by that authority. This was the main cause, in my belief, why these works proved unacceptable to the starving people, and consequently of little value in lightening their distress. It was not surprising that people unaccustomed to work on roads, and with a known dislike for such labour, should decline to work for money which could not obtain for them food.—(Extract from Minute, dated 28th April, 1869.)

NOTE ON LORD LAWRENCE'S MINUTE.

This (minute of the Governor-General) must be regarded, however, at best, as but a poor attempt to shuffle off the responsibility. The Supreme Government were neither deaf nor blind nor dumb, they could read the papers, and they could not help hearing what was being talked about everywhere. If a "terrible calamity" was impending, and the local government were taking no effective measures to meet it, were the Supreme Government tied hand and foot that they could not remonstrate?—(From Pritchard's "Administration of India.")

FAMINE WARNING TO THE INDIA OFFICE.

(Extract from letter of Sir Arthur Cotton, R.E., to the Under-Secretary of State for India.)

SIR,—*The immediate prospect of famine in Bengal* will perhaps be considered a sufficient reason for any person who has seen such times in India offering a suggestion on the subject. On the two last occasions of famine in Madras, nothing whatever was done, after the certainty of their occurrence was seen, to prepare for them, in consequence of which the most terrible misery and loss of life followed, most of which might certainly have been prevented, had means been used, perfectly within the reach of Government. It is certain that the public of this country will most heartily support any measures that may be necessary to provide funds, &c., to rescue millions of their fellow-subjects from death. I need hardly add that *now not a moment is to be lost if anything effectual is to be done.* The season is already well advanced, and it will be necessary to give ample authority by telegraph to the local authorities to use funds and all other means freely, with the assurance that arrangements will be made here to secure ample supplies of money.

I conclude by repeating that I trust that, in such an extreme case, such a suggestion as is here respectfully made may be excused and considered.

I have the honour to be, my Lord, &c.,
(Signed) A. COTTON,
December 28th, 1865. *Royal Madras Engineers.*

WARNING DISREGARDED BY THE INDIA OFFICE.

INDIA OFFICE, LONDON,
January 12th, 1866

SIR,—I have laid before the Secretary of State for India in Council your letter, dated 28th ult , offering suggestions as to the measures to be taken for guarding against the consequences of a famine in Bengal, which you believe to be imminent, and in reply I am directed to state that Sir C. Wood trusts that *there is no reason to apprehend that any general famine is likely to be experienced in the Lower Provinces of Bengal*, but he has every confidence that, should such a calamity unhappily occur, the local government and the Government of India will not fail to take all necessary measures for protecting the poorer classes of the population against the effects of the visitation.—I am, &c.

(Signed) HERBERT MERIVALE.
To SIR ARTHUR COTTON, R.E.

DOING NOTHING IN PRESENCE OF AWFUL CALAMITY.

The only man who would seem to have divined its real character was Sir Arthur Cotton, who as early as December, 1865, pointed out, in a letter to the India Office, "the terrible effects" that had followed in Madras in former years upon a system of *doing nothing* in the immediate presence of such awful calamity. With prophetic insight he at once urged upon Sir Charles Wood the very measures which, eighteen months later, the Commission appointed to report upon the subject urged should have been adopted.—(*Times of India*, 12th December, 1868.)

EVIDENCE OF MR. JAMES GEDDES, B.C.S., BEFORE THE PARLIAMENTARY SELECT COMMITTEE, JULY, 1871.

I was sent with special powers as collector and magistrate in the three districts of Orissa to administer relief in the famine.

Among the different antecedents, variable and invariable, which led to the famine, the chief antecedent which could have been varied has never, I think, been sufficiently adverted to, and that antecedent was the weight of the Government taxation. That the food reserve of one year, the proceeds of the crops of one year, being sold off to pay the taxes, insufficient was left for the following year in which the rains might fall short. There seems to be a very great difference between a condition of society in which the produce of the land is consumed upon the land, and a condition of society in which a portion of the produce has to be deported to a place on the other side of the globe, and still more so when the industry of the taxpayer is only agricultural. As soon as the harvest of 1865 in Orissa could be appraised by the cultivators, the zemindars all pressed the Government to remit the land revenue demand falling due at that time; the zemindars knew whether the ryots, after parting with the portion of their crops required for defraying the Government revenue, would have enough of grain remaining to enable them to tide over the following seed-time, and survive till the following harvest. The answer which Government gave to these petitions of the zemindars and ryots was a reminder that the cultivators were getting higher prices than usual for their grain, and a refusal to suspend the Government demand.

In Orissa in the end of 1865, and in the beginning of 1866, there was a perfect panic in all money matters throughout the province. The people dealing in grain, the people corresponding to bankers in carrying on the business of the country, suffered a collapse of credit; the shutting of their shops was the first serious indication to the Government of the extent of the calamity. Assuming that the land revenue remained fixed at, say, one-seventh or one-fifth of the gross produce of the year, and that the yield of produce is seven times the seed, you must consider the necessity of parting with so large a proportion of the crop in order to meet the land revenue and other demands as part of that very problem of famine. The burden of explaining how there should be famine at all rests upon a foreign Government whose subject taxpayers die of starvation by the million.—(Extracts from Evidence taken before the Select Committee, July, 1871.)

THE COST OF FLOODS IN ORISSA.

Every ten years many hundred thousand pounds' worth of property are swept away by the furious rivers. In 1866, the floods burst through the embankments in 478 places; they submerged 1,049 square miles of country; a million and a quarter of people were suddenly driven out of their homes, and found themselves in the midst of a vast boiling ocean aggregating more than a thousand square miles. This sea varied from three to fifteen feet in depth, and covered the earth for a period of from three to sixty days. One fiscal division, indeed, lay buried beneath the vast accumulation of water, nowhere less than a month, and in some parts for as long as seventy days.

Close upon eleven million hundredweights of rice were destroyed, at the very moment when every hundredweight of rice was life or death to some miserable peasant. It was at the end of the famine of 1865—66, and, at the rates which then ruled in Cuttack town, the money value of the rice destroyed exceeded three million pounds sterling. These were the losses of a single year; and although the flood of 1866 continued longer, and was therefore more destructive, that of 1865 was deeper When at length it subsided, and the ruined peasantry crawled back to their villages, they found their once trim homesteads buried in filthy slime, the thatch roofs torn off, and the crops, upon which their life or death depended, turned into a pestilential swamp of rotting rice-stems. Great as the pecuniary loss caused by such a flood may be, no sum of money can represent the damage which the liability to such inundations does to a province. It discourages any attempt to accumulate capital or to improve the land. A single night may sweep away the accumulations and the improvements of a lifetime. In short, it takes the heart out of the peasantry, and neither landlord nor tenant will spend a rupee upon doing anything for a province in which the returns are so uncertain.

In Cuttack division we found, in 1803, when we took over the country from the Mahrattas, 1,006 miles of embankments. Of this nearly one-half has since been abandoned, and we have vainly struggled, by tinkering at the remaining ones, and extending them, to protect the territory from inundation.

From 1816 to 1866, the Government remissions of the land-

tax on account of floods exceeded a quarter of a million sterling. Orissa had been subject to repeated famines on account of drought, and another quarter of million sterling has been remitted from the Government land-tax, on account of such scarcities, between 1831—32 and 1866—67. Adding together, therefore, the expense of maintaining the embankments, and the remissions of revenue which the inefficiency of the embankments necessitates, we have a total of £729,132 as the cost of the uncontrolled rivers of Orissa during a little over half a century. This sum is equal to the whole average land-tax of the province for five years, and it is not too much to say that every rupee of it has simply been wasted in temporary makeshifts, and that Orissa was worse off in 1866 than in 1803, when we took possession of it.

She has abundantly bestowed her gifts upon the province—good soil, health-giving sea-breezes, an adequate rain-fall, and noble rivers; what more can a country ask? But so long as man fails to utilise and control the vast stores of water which the rivers bring down, Orissa will continue subject to the most appalling calamities.—(*Pioneer.*)

DR. HUNTER ON ORISSA FLOODS.

In the single division of Puri more than twelve square miles of solid land were suddenly turned into a sea between seven and nine feet deep, and this sea continued to cover everything for thirty days. Thousands of miserable families floated about in canoes, on bamboo rafts, on trunks of trees, or on rice-stacks, which threatened every moment to dissolve into fragments beneath them. No lives were lost in the first rush of waters, for the unhappy inhabitants of these regions know but too well from previous experience what they have to expect, and live in a constant preparation for calamity. Most of the hamlets have boats tied to the houses; and for miles the high thatched roofs are firmly held down by bamboo stakes, so as to afford a refuge in time of flood. Starving colonies might be seen thus perched above the waters. Every banyan tree had its rookery of human beings, while the Brahmans effected settlements on the roofs of their brick temples, and looked down in safety as the flood roared past. Sheep and goats were carried away by herds in the torrent, and in a few days their carcasses came to the surface and floated about covered with crows and scuffling kites. But the most pitiable sight of all was the

plough cattle standing in shallow parts up to their necks, and hungrily sniffing the barren waters for food until they sank exhausted into the slime. Many a famished family had also sunk beneath the waters —(Extract from "Orissa," by Dr. W. W. Hunter, LL D. London, 1872.)

AN EXAMPLE OF THE ANNUAL LOSS TO RAILWAYS FROM FLOODS.

(Extracts from the official Report, 1871)

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY, 1870.

Damage was done to some of the works on the line between Surat and Ahmedabad by the floods of August. The Mhye and Nerbudda bridges suffered slightly, but the bridge over the Watruck River was carried away, the whole of the superstructure being closed up with drift, and offering a solid dam to the stream which overpowered it.

SCINDE, PUNJAB, AND DELHI RAILWAY, 1870.

Great damage was done to the bridges over the Guggar, Sirhind, and Beas Rivers. One pier of the last-mentioned yielded to the force of the water, and the girders were carried away and lost. The traffic was interrupted, but was resumed within a few days.

EASTERN BENGAL RAILWAY, 1870.

This line suffered great injury from the floods, both in respect to the works and the traffic. Viaducts, culverts, and embankments were washed away; and, besides an interruption in the ordinary traffic, a large traffic in jute, which at the time of the inundations was at its height, was suddenly lost. Efforts were made to arrest the destruction, and, when that ceased, to repair the damages. The passenger traffic was resumed in a few days, but the line was not fit for the goods traffic for about eight weeks. There was, consequently, a decrease in the revenue receipts.

COST OF REPAIRS.

Unprecedented rains occurred in different parts of the country during the year, producing disastrous effects upon some of the railways. The Punjab and Delhi. the Eastern Bengal, and the Bombay, Baroda, and Central Indian lines suffered the most damage. The cost of the necessary repairs and alterations on these lines will amount to at least £300,000.

DROUGHT IN THE COTTON DISTRICTS OF DHARWAR IN 1866.

(Extracts from Reports by the Collector and Deputy-Collectors.)

The distress in the Dharwar districts reached its height in August, September and October, 1866. The talooks in which the greatest destitution appeared were Nowulgoond, Roan, and Dumbul. A fair harvest was looked for until August, when, owing to the rains keeping off, grain had not only become dear, but scarce in the market, and most distressing accounts of the condition into which the poorer classes were plunged continued to reach the collector. The cultivators are prevented from following their usual pursuits; many people have been reduced to beggary, and still more have left their homes and gone to seek a livelihood elsewhere. The town of Dumbul has been deserted by its inhabitants to a great extent, and presents a very melancholy appearance.

ORDINARY AND FAMINE PRICES OF FOOD.

On the last market-days at Nawulgoond and Nurgoond, common rice was sold at $3\frac{1}{2}$ seers per rupee. The following rates show the rates of grain sold at Dharwar during the distress and in ordinary times.

	Price during Distress Per rupee	Ordinary Price. Per rupee.
Jowaree	6 seers	21 seers
Bajree	$5\frac{1}{4}$,,	$19\frac{1}{2}$,,
Rice, 1st sort	$4\frac{1}{4}$,,	10 ,,
,, 2nd sort	6 ,,	$11\frac{1}{4}$,,
Dal	$4\frac{1}{4}$,,	$10\frac{1}{2}$,,
Kooltre	$6\frac{1}{2}$,,	21 ,,
Horse grain	$3\frac{1}{2}$,,	$5\frac{1}{2}$,,

All the tanks and some of the wells I inspected since leaving Dharwar I found completely dry, the villagers being thus obliged to resort to nullahs and holes several miles away, the supply of water in which being small, occupied a good deal of time in collection and conveyance. The poor are suffering from the want of the very necessary of life, viz. food and water.

DISTRESS IN BELGAUM IN 1866.

Brigadier-General commanding to the Commander-in-Chief:—The prices of all necessaries of life have risen enormously,

the greatest difficulty exists in getting supplies of grain sufficient for the troops—that for some days sepoys and followers were unable to procure any.

No jowaree, no grain, no wheat, is procurable at any price, nor have they been for some days. The road from hence to the Ghat has been untouched for some years, and is very much out of repair in many places, and in the present state of distress, which I regret exists to an alarming extent, the temporary employment of many of these poor creatures may be attended with great advantage to the Government.

DROUGHT IN THE CENTRAL PROVINCES, 1868.

The monsoon broke early in June, and the first fall was sufficiently favourable to induce the greater part of the cultivators to commence growing. In a short time thousands of acres were sown. But day after day went by without rain, which killed all the seed that was not artificially kept alive by irrigation, and it was not till after nearly a month of drought that rain fell for the second time, and the cultivators, taking fresh heart, recommenced their sowings from the beginning. But when the second fall proved almost as illusory as the first a feeling of real alarm spread through the country, and the large grainholders showed everywhere a disposition to lock up their granaries. This closing of the markets was severely felt, not only by the poorer classes, but by those who having money were unable to buy, and at once relief works were opened out, and the importation of grain was encouraged by the authorities. The worst accounts of all were received from Chuteesgurh, the eastern division. The country has every requisite for prosperity, but the ties of landlord to tenant and of tenant to soil are still weak. Thus there is a want of cohesion and solidity in the social structure which weakens the power of the people to resist the pressure of general distress, added to which the very abundance of Chuteesgurh in ordinary seasons intensifies suffering in years of failure. Food is ordinarily almost a drug, and wages are correspondingly low. When, therefore, a time of emergency comes, and prices rise to the level prevailing in the surrounding country, the whole conditions of life are changed so suddenly to the classes supported by money earnings of a more or less fixed character, that the struggle seems almost impossible to them, and they hardly make an effort to bear up against their difficulties. So long as relief works

passed through the heart of the distressed tracts the people were willing to accept life at the cost of labour; but when it came to be a question of going forty or fifty miles for their works, the majority preferred slow starvation life on jungle fruits. It was therefore found necessary in selecting works for execution chiefly to consider their accessibility to the suffering classes.

The scale of wages was fixed at 1½ anna (twopence farthing), 1 anna for a woman, and ½ anna for a child. It was gratifying to note to how great an extent the public spirit and humanity of the people was called forth. Mr Morris writes, "Much that was done by natives for their starving brethren never came to the knowledge of public officers; but the more we learned of their work, the more we had reason to admire the charity, not without organization, which they displayed throughout the whole of the crisis of the famine."

The direct loss of produce in consequence of the drought is roughly estimated at 17,000,000 maunds (2,833,333 qrs), valued at £3,400,000, in addition to the indirect injury to the prosperity of the country from the waste of labour, the contraction of trade, and the diminution of the population.—(Extract from the Blue Book of India, "Moral and Material Progress of India," 1868—69, pp. 40, 41.)

EXAMPLES OF GOVERNMENT LOSSES FROM FAMINES.

(Extract from a Report by Mr. (now the Hon) R. S. Ellis, C B., Chief Secretary, Government of Madras.)

£92,000 *Loss in two Districts only*.—In Salem the drought had produced a decrease of 320,441 acres in the area under cultivation, and a loss of Government revenue amounting to £49,508. In North Arcot the decrease in the area under cultivation had been 169,345 acres, and the loss of revenue £43,054.

In both the districts which I have recently visited much remains to be done; and there are in the records of the Board of Revenue and of the Public Works Department plans of irrigation works which, if they had been executed, would not only have been highly remunerative, but would have this year made the serious failure of rain result only in a partial instead of an entire loss of crops. It is beyond my province to do more than allude to this question; but it was impossible that it should not be constantly a subject of thought and regret, for there was scarcely a village through which I passed, in company with the

district officers, where there was not the same complaint of breached tanks and channels out of repair; while in many places great natural reservoirs were pointed out to me, which only required a comparatively moderate outlay of money to bring into cultivation large tracts of country now lying waste. Considerable rivers and streams are allowed to flow away into the sea, carrying away the drainage of thousands of square miles of country; which if retained by a carefully improved system of dams in the river valleys, with connected channels, might store water sufficient to carry the crops through even as severe a season as that which we have recently experienced. (21st September, 1866.)

Loss of £30,000 in Salt Revenue, 1868—1869, *Central Provinces.*—Usually salt for the Saugor and Nerbudda territories is brought by pack bullocks from the native states of Rajpootana; paying duty on crossing the line inwards at Saugor, it has been passed on to Jubbulpore, thence to be distributed over the country. But the grievous famine in Rajpootana in the year under review, the scarcity of water and forage, gave a check to the usual course of trade, the imports from that direction were reduced by 100,000 maunds, and there was a loss to the revenue in Customs' duty of nearly £30,000.—(Report, "Moral and Material Progress of India," 1868—69, p. 46.)

£14,000 *Annual Charge for Orphans.*—There is a very heavy expense which is incurred since 1856-7 for maintaining orphans after the great famine; of late years that has thrown a charge which amounts at the present time to £14,000 annually upon the Government.—(Minutes of Evidence, 1872, vol. ii. p. 267.)

Less Consumption of Cloth.—The effects of the late famine will, I believe, last for two years more as regards the prosperity of the people; and I calculate accordingly that during these two years, as it has been for the past two, the consumption of cotton cloth in this district will not be more than 30,000 maunds per annum, or about one seer and thirteen chittacks per individual (3 pounds 10 ounces: the consumption per head of population in the United Kingdom is 45 pounds).—(Extract from Deputy-Collector's letter to Board of Revenue, Allahabad, December, 1869.)

THE FAMINE IN RAJPOOTANA IN 1868—69.

BY COL C. BROOKE, POLITICAL AGENT, &c

FAILURE OF RAIN.

Rajpootana depends for its rain supply on two sources, the south-west monsoon and the eastern monsoon. The first, striking the coasts of Kattywar and Kutch, expends its force on the high ranges of hills of those countries, passes with lightened clouds to Mount Aboo and the slopes of the Aravalli, and has little rain left for Ajmere and Central Rajpootana. The eastern monsoon sweeps up from the Bay of Bengal along the valley of the Ganges, plenteously supplying the eastern and, if in force, the central districts, but seldom reaching Marwar, Jeysulmere, and Bickaneer, to the west. Going from east to west we go from a land enjoying a plentiful and equal rainfall to one with an uncertain one, and finally to one in which hardly any rain falls. The failure of one or the other monsoon produces a local famine over the countries under its influence; the failure of both, as was the case in 1868, produces what the natives call a treble famine—a famine of grain, grass, and water, the three great necessaries of existence. In the former case grain is obtained from the more favoured districts, and the population find temporary refuge there till the return of the next rainy season. In the latter case they have no such resource; the people wander from place to place till their cattle have perished, their savings are expended, and they themselves either ask for alms, or in the case of the mass of the proud Jât cultivators, lay themselves down to die, for they will neither take by force, it is recorded of them, what does not belong to them, nor will they, as they consider, lower themselves by taking wages for labour. They regard themselves as servants of the soil, and from the produce of the soil alone will they deign to live.

The rainy season of 1868 commenced early in June. The first falls were succeeded by a long break, during which the grass sprouted and withered away again. The husbandman, however, ploughed his fields, and sowed his seed. A second fall of rain in the early part of July caused the crops to attain a height of about twelve inches, and the grass to appear again, but not sufficiently high to be grazed by cattle. No other showers succeeded. The stunted crops made futile efforts to form heads of seed, and the grass became thinner and thinner, till the fierce

October sun burnt up altogether what remained, leaving Marwar an arid and withered expanse. There was not a blade of grass to cut, and the seed sown was lost. Within an area of 100,000 square miles, or five-sixths of the whole country, the suffering was very great; in parts of the native states, and throughout British territory, it was intense.

GREAT EMIGRATION OF POPULATION.

The Marwar ryots, without losing heart, prepared to meet the dreadful calamity, and to absent themselves from their native land till the returning seasons should hold out more propitious prospects. The roads they took were various. From Nagore and the northern pergunnahs of Marwar, whence scarcity of water alone would have compelled departure, they passed through Rewarree to Delhi and the Punjaub. Two mighty streams of human beings and cattle poured from the south-eastern portion of the country. The greatest crossed the Arravalli Mountains at the Deysooree Pass. Numbers have been passing through Meywar in a starving condition. Brigadier-General Montgomery, commanding at Neemuch, writes :—"The Marwarees are taking back but few of the cattle brought down. Numbers of these poor people die by the way. Some are left to be devoured by dogs, and others are buried a few inches below the surface of the ground, and always in nulla beds, in view that the remains may be swept down by rain to the sacred rivers."

The second great stream of emigrants passed *viâ* Phalunpore into Guzerat and some towards Radhunpore. They, too, were doomed to bitter disappointments. The great floods which devastated Guzerat in August, sweeping grass and kurbee stacks, as well as villages and cattle, into the sea, buried the growing grass and left a desert for the Marwar herds. They were driven further, dying of starvation at each stage, till a few only reached the jungles east of Baroda. Here difference of climate and forage killed off large numbers, and the emigrants have been beggared. In addition, nearly all the artisan and lower classes left the country. The Guzerat floods gave employment to these in the rebuilding of the towns and villages which had been swept away.

VILLAGES OF THE DEAD.

The northern portion of Marwar is deserted. In the more fertile portions the towns are still inhabited, but the villages

are as villages of the dead, only a few women and one or two men being left to look after the houses. So long ago as last September I calculated that three-fourths of the population had left the country, and I have found no cause to change my estimate further than excluding from it the Jeytaram, Sojut, and Godwar purgunnahs.

LOSS OF POPULATION, ONE MILLION TWO HUNDRED AND FIFTY THOUSAND.

There is no doubt that the population of the country will be permanently diminished—I should say by a quarter less than it was before the famine. Any native state will welcome the advent of the hard-working and thrifty Jâts, of whom the mass of the agricultural class is composed; and though they would naturally return to their own homesteads, yet penury and the loss of the means of ploughing their fields will act as a great check to their return. In the whole tract affected by famine, it is computed that 1,250,000 human beings died from starvation and disease.

LOSS OF CATTLE, TWO MILLION HEADS.

Besides the loss of population, the loss to Marwar in the destruction of its great mainstay, its cattle, is dreadful to contemplate Marwar, over its greatest extent, is essentially a pastoral country. Large herds of magnificent horned cattle, of the species used for native Ruths and Bylees, and called Nagore cattle, from the name of the principal place where they are bred, roam over its plains, which yield a peculiarly nutritive perennial grass. In the dry climate, and on a soil peculiarly suited to them, they thrive and increase rapidly, and the young are sold at the annual fairs for 80 to 250 rupees a pair. They are, consequently, a source of wealth and prosperity to the country. Their peculiar constitution was not able to resist the scanty and miserable fare to which they were doomed during the famine; and, therefore, the loss in this species of cattle has been very large.

There are about 4,500 inhabited villages in Marwar; and if we reckon 1,000 head of cattle per village, or even 500, we shall have 2,250,000 herd of horned cattle for the country. All these, with the exception of about one-tenth, were taken out of Marwar by the departing emigrants. Two millions, at least, of cattle, and three-quarters of a million of human beings, poured

in great floods over the neighbouring countries! Where, however, are now the cattle? The tenth which remained behind may be said to have died off. The masses of bones round the villages, and the few walking skeletons left, attest the frightful mortality. An almost equal mortality appears to have followed the herds. Those that went to Malwa suffered fearfully. The emigrants to Guserat and Radhunpore have lost most of theirs: and when to these are added the numbers which have been sold for a mere trifle for the purchase of food, I do not think I shall be exaggerating when I say that the wealth of the country in its horned cattle will have been reduced to one-fourth what it was at the same time last year—a loss which is unprecedented. Marwar alone, before the famine, had at least two and a quarter millions of horned cattle, single households possess hundreds of them, and some large dealers several thousands, and in such numbers are they bred, that the neighbouring provinces are supplied, the produce being yearly sold at great fairs, where the price of a large pair of bullocks ranges from £15 to £40, smaller ones fetching from £4 to £8 per pair. Sheep are exported largely to our military stations, and supply the Bombay market.

COUNTRY PARALYZED FOR YEARS.

In Scinde grain is already getting scarce, and the convoys thence are diminishing in number. In Balmere grain is not procurable for money, those who have none being obliged to subsist on wild berries. The nominal bazar rate (for grain) is $5\frac{3}{4}$ seers per rupee, but the real rate is only $4\frac{1}{4}$: and at this price there is a scramble for it as a store is opened. The famine will paralyze the energies of the country for years to come, and a long repose will be needed before Marwar will recover the heavy losses to her material prosperity caused by the fearful calamity.

The Jarejajee Ranee distributed daily seven maunds of cooked food, besides double handsful of grain after night-fall to the numerous class who are in too respectable a position to beg, and yet have been cruelly straitened by the late high prices. The Bunnya class were also very charitable, and many distributed food to the poor —(Extracts from Marwar Agency Report of Colonel J. C. Brooke, Political Agent. Selections from the Records of the Government of India, No. 73, 1869, pp. 105—110.)

MODE OF DISTRIBUTING CHARITABLE RELIEF.

It appears, however, very questionable, from the experience gained, whether it is advisable to demand work from the feeble poor at such times It certainly diminishes the chances of their recovery The support of the able-bodied poor saves an immense number of lives. Tender nursing and not labour is required when starvation has seized the human frame. In native states, dole or half ration is given, but nothing is required in return. Whenever famine labour has been exacted from the feeble poor in return for food, it has been always very unremunerative. During the Rajpootana famine, a loss of seventy to eighty per cent. of the outlay was not unusual. Not only should we sustain the very feeble and infirm, but we ought, in an economical point of view, still more to preserve the comparatively able, who are the thews and sinews of the State. Without relief they also would have starved.—(Report of the Agent to the Governor-General in Rajpootana. Overland Summary, *Times of India*, p. 8.)

LORD MAYO ON THE RAJPOOTANA FAMINE.

14th February, 1871.

The Viceroy and Governor-General in Council has read this report with deep interest. It is a most valuable record of a terrible calamity rendered still more terrible by the cholera and fever which followed in its track. So severe and widespread was the drought of 1868, that not only was it found impossible to cultivate the land, but from want of sustenance the pack-bullocks, on whose loads of foreign grain the country so much depends for an adequate supply of food, even in ordinary times, died in large numbers, and thus importation was brought nearly to a standstill. Within an area of one hundred thousand square miles the suffering was very great; it was intense in parts of the native states and throughout British territory. It is estimated that, from Marwar alone, one million persons, or two-thirds of the entire population, emigrated, taking with them more than two million head of cattle. In the whole tract affected by famine, it is computed that one million and a quarter of human beings died from starvation or disease. The sum total which the Government spent for the relief of the population of its own territory, numbering 426,000 souls, was 15,20,074 rupees. This sum is equivalent to nearly three years' gross revenue.

The Government of the North-Western Provinces will be asked to consider the remarks made by you in the fifty-second paragraph of your report on the subject of the late remissions in Ajmere.—(C. E. R. Girdlestone, Under-Secretary to the Government of India, to the Agent of the Governor-General, 14th February, 1871.)

SAD SCENES ROUND VILLAGES IN RAJPOOTANA, 1869.

The end is told by the whitening bones lying round every village, over which pariahs and jackals quarrel with birds of prey. Nothing, we are told, can equal the desolate appearance and depressing solitude of some of these deserted villages. In some instances not a soul remains. In others, a few miserable-looking wretches represent the community which formerly rendered the locality alive with sights and sounds of human occupation.—(*Times of India*, 23rd January, 1869.)

STILLNESS OF DEATH IN 1870 IN MARWAR.

This formerly rich country is now poverty-stricken. Its herds are gone. Even the field rats have been starved out, and insect life has notably diminished. The stillness of death is felt everywhere. Such was the condition of Marwar in May, 1870.—("Moral and Material Progress of India," P. R. 230. 1871.)

The cultivator, always more or less in debt, is now irretrievably so; his cattle, his household, all are gone. The Mahajun classes, jointly as co-operatives and privately as individuals, distributed grain, food, and clothing; and at more than one place, in order that succour might reach those ashamed to accept relief publicly, they sent round supplies after dark.

FIVE TIMES THE NUMBER PERISHED IN RAJPOOTANA THAN IN THE WARS IN 1870 BETWEEN FRANCE AND GERMANY.

It is truly surprising how little attention was given in England, we might almost say in India, to this terrible famine which swept away a million and a quarter of our fellow-men. How many have perished in the recent bloody war between Germany and France? Perhaps a hundred thousand. The killed and wounded were, let us say, a quarter of a million. How profound the interest awakened in their behalf in England! How readily have all classes engaged in measures

of relief; what large sums have been contributed; how many portly volumes would be filled with the leaders written; and yet five times the number of persons perished by a still more cruel death in Rajpootana, and there is scarcely the slightest agitation of the surface of public sentiment. Must such things continue! Shall there be, next year, say, another famine in some part of India sweeping away another million of men, women, and children? Who is responsible for the prevention of such famines?

The famine in Orissa may be forgotten or ignored, in the three brief years which have passed since a third of its population were deliberately allowed to whiten the fields with their bones. The famine which has swept off half a million of human beings in Rajpootana still leaves its mark on Ajmere and Mhairwara. Half a million died in silence. Ajmere is cut off from our ordinary territory by a breadth of two hundred and sixty miles of almost pathless country. The calamity is too recent, and, we believe, the Lieutenant-Governor is too conscientious to allow the hideous truth to be hushed up in official secrecy. The warning which the dying millions of Orissa sounded low and late into the ears of Lord Lawrence, has now reached Lord Mayo from Ajmere and Rajpootana.—(*Friend of India*, February, 1870.)

FAMINE ASPECTS OF BENGAL IN 1874.

(By Dr. W. W. Hunter, B.A., LL D., Director of Statistics, Government of India.)

BENGAL HARVESTS.

Many districts depend almost wholly on the December or *aman* rice; in a few the September *aus* rice would enable the people to live through the year without absolute famine; in others, the spring crops (rabi) form an important supplement to the rice harvest.

LOW EARNINGS OF THE PEOPLE.

The following statement exhibits thirty-eight millions and a half of labourers and agriculturists, out of a total population of

fifty millions included in the forty districts, or three-fourths of the whole population. It would be beyond my knowledge to say what proportion of these labourers and agriculturists are within reach of starvation during a famine. But the following rough estimate may be useful. I consider that nine millions and a half, or one-fourth of them, do not earn more than 5 rupees (ten shillings) a month, or say 3 annas a day, during a working month of twenty-seven days; another quarter of them earn between 5 and 8 rupees (*i.e.*, between ten shillings and sixteen shillings) a month. The earnings of another quarter of them may be put down between 8 and 10-8 rupees (*i.e.*, sixteen to twenty-one shillings) a month. The remaining quarter averages about 12-8 rupees a month (twenty-five (shillings), and very few even of this comfortable class can afford to spend over 16 rupees (or thirty-two shillings) per mensem.

FAMINE WARNING.

Allowing for the different circumstances of each district, the figures disclose a surprising unanimity, both as to what rates in January should be accepted as a warning of famine, and as to the point at which actual famine is reached. With the exception of the Orissa and Kuch Behar divisions, whose circumstances are peculiar, the district average of each of the other six divisions (comprising thirty-two districts) only varies from 2-6 rupees to 2-10 rupees as the price of rice per maund, which, if reached in January, forms a warning of famine later in the year. The same remarkable *consensus* is disclosed as to the point at which prices amount to actual famine, and at which relief works should begin. In the two great adjoining divisions above the delta (Patnâ and Bhágalpur), with their twelve districts and nineteen millions and three-quarters of inhabitants, the district average famine rate is precisely the same, viz. 3-14 rupees per maund for common rice. The three adjacent divisions of the delta (Rájshâhí, Bardwân, and the Presidency), with their fifteen districts and twenty-two millions of inhabitants, exhibit an equal uniformity. Famine warnings in the two northern adjoining ones average 2-10 rupees for rice in January; and in the three, the actual famine rate varies only from 4-1 to 4-4 rupees for common rice per maund. In Orissa, the people are poorer, the purchasing power of silver is greater, and the returns give a lower price both for the point of famine warning and for that of actual famine rates.

TABULATED SYSTEM OF FAMINE WARNINGS.

Name of Division.	Total Agriculturists and Labourers.	Famine Warnings. Rice per maund in January, District Average.
Patná	10,189,080	Av. Rs. 2–7
Bhágalpur	5,259,606	,, ,, 2–9
Rájsháhí	7,146,522	,, ,, 2–10
Kuch Behar	738,645	,, ,, 3–5
Chota Nágpur	2,960,694	,, ,, 2–8
Bardwán	5,590,380	,, ,, 2–10
Presidency	4,327,770	,, ,, 2–6
Orissa	2,102,040	,, ,, 2–3
Total	38,314,737	Av. Rs. 2–9–6

THREE AND A HALF FARTHINGS RISE MEANS STARVATION.

Price of Rice.	*Per Rupee.*	*Per Maund.*	*Per lb.*
In prosperous years	30 seers	Rs. 1 5	1½ farthings.
Famine warnings in January	15 ,,	2 10	3 ,,
Actual famine	10 ,,	4 0	5 ,,

These figures very forcibly suggest the extremely small difference (when expressed in English money) between plenty and scarcity. Three and a half farthings per pound represent the whole intermediate area between a year of prosperity and one of famine; while there are only two farthings per pound between the rates which amount to a famine warning and those at which the famine point is reached. These facts explain the invariable and urgent demand by the native community to prohibit exportation during famine.

WHY EXPORTS OF RICE CONTINUE DURING FAMINE.

I am told that the retail price of rice in Europe may rise a few farthings a pound without causing anything like a sudden cessation of the consumption. But in Bengal, two farthings make the whole difference between a famine warning and the famine point, and three and a half farthings per pound the whole difference between a time of plenty and a time of famine. It is clear, therefore, that as a difference of a few farthings does not cause a cessation of the demand in Europe, exportation will go on although these same few farthings may mean starvation for the Bengal peasant.

Actual experience proves that export of rice is checked, but not stopped, by a rise of rates to famine prices. Toulmin's Weekly Circular shows an annual average export of rice from Calcutta for the ten years ending December 31, 1872, of nine million maunds. It shows that during the year of extreme famine, 1866, the exportation only dropped to five million of maunds, and the average of the three years, 1865-66-67, was nearly seven and a half millions. In October, 1873, in the presence of an impending famine, 278,944 maunds were exported. During the *ten* months of actual scarcity in 1866 (from January to October), the export of rice from Calcutta exceeded three and three-quarter million of maunds.

Such facts explain, and to some extent justify, the native outcry for an embargo during a scarcity. The few farthings which signify little to the European consumer mean actual famine to the population of Bengal. Allowing the liberal yield of seven maunds of paddy per bigha, or four maunds of rice per bigha, and twelve maunds of rice per acre, the exportations in October, 1873, from Calcutta swallowed up the produce of 23,245 acres in a fruitful year, or over 50,000 acres. Even under the pressure of the terrible crisis in 1866, the exportations of rice from Calcutta represented 422,210 acres of rice land in fruitful years; 1,688,840 acres in that year with its quarter crop, and 1,266,630 acres in 1873 with its one-third crop.

CONCLUSION.

Different ideas are entertained as to the point at which scarcity amounts to famine, but for political and financial purposes, this point may be taken to be that at which Government relief operations become necessary—that is to say, when, in order to save the people from starvation, the State has to find work and food (or wages) for the able-bodied, and to give food in charity to those who are incapable of labour. If Government is to deal adequately with a scarcity, it must take action at or just after the December harvest. But a famine does not actually develop itself till several months later, and Indian governors have hitherto shrunk from a vast outlay in December with a view to avert a possible calamity next May.—(Extracts from the work of Dr. Hunter. London, 1874.)

FROM THE "INDIAN ECONOMIST."

If food is in the country, and the people are allowed to die of starvation in its presence, the entire executive administration

that suffers them so to die deserves impeachment. There has been no famine in our time, 1847—1873, that might not have been successfully encountered by the State. But success is impossible, if the lives of the people are to be weighed against the cost of saving them. There should be but one rule of conduct in such emergencies; and at the head of every circular order that leaves the Government there should stand—The State will condone all mistakes but that of letting the people die.

1873-74 AND 1769-70. A COMPARISON OF TWO FAMINE PERIODS IN BENGAL.

We have no drought on record in India the area of which was so extensive as that of 1873-74. Oudh, Azimgurh, and Goruckpore seem never before to have been so afflicted; but Goruckpore is now suffering severely, and even Oudh has not escaped. The cause of famine, in so far as Bengal is concerned, and in so far as it is produced by drought, is uniformly the same. It is not that the rainfall is insufficient, but in every case that the rains cease prematurely. The critical period of the season is from the middle of September to the end of October. If the rains cease by the middle of September, the great food-harvest of the Lower Provinces is withered and burnt up. The history of these calamities shows, moreover, that the country is subject to cycles of drought. The period of distress is well marked and uniform in all cases. The dearth begins to be felt as early as October of the stricken year. The gathering of the amun brings temporary relief from December to February. The period of famine or starvation sets in about April, and culminates about the time the bhadoi, or aush crop, is reaped in August and September.

The summary for the districts suffering in 1873-74 is as follows:—

Districts.	*Population.*
Bardwan	7,286,957
Presidency	6,097,863
Rajshahye	8,893,738
Patna	18,122,743
Bhaugulpore	6,613,358
Chota Nagpore	3,419,591

These districts comprise 47,000,000 people, who, after two successive years of indifferent harvests, have to be maintained for nine months.

A careful review of all the notices we have of the famine of 1769-70 in the letters and proceedings of the Councils at Calcutta and Murshidabad impresses us with the conviction that the season of drought in 1873-74 strikingly resembles it in its main features. The area of the drought seems to have been precisely the same. The rains ceased prematurely in September, 1769, just as they did in September, 1873.

MINUTE OF WARREN HASTINGS.

Two years after the famine, Warren Hastings, after a progress over a great part of the provinces, recorded his sorrowful conviction that "at least one-third of the people had perished" in the calamity. He makes this statement, moreover, in close connection with a review of the land revenue collections. "It was naturally to be expected," writes Hastings himself, "that the diminution of the revenue should have kept equal pace with the other consequences of so great a calamity, that it did not was owing to its being violently kept up to its former standard." And it was this violence that eventually destroyed the landed classes of the country, and plunged Bengal into the dreadful miseries subsequently pourtrayed by Burke in such lurid colours in the famous 9th Report of 1783. We read of the native princes and zemindars being dispossessed of their territories, browbeaten, imprisoned, and subjected to every indignity to "keep the collections up to their previous standard." We read, twenty years afterwards, of "farmers" still in prison for their default at this period, without hope of regaining their liberty.

LAND REVENUE AND FAMINES.

The truth is, the screw was put on with such relentless severity, that the people were skinned of everything the famine had left them. The Maharajah of Bardwan was imprisoned for the arrears of his deceased father, the Rajah of Nuddea dispossessed of the management of his estate, the Rani of Rajshahi (an admirable woman) threatened with the same indignity. The farmers at last threw their task up in despair. We have the clearest evidence that in Birbhum, at least, the result of it all was that a third of the district became jungle, while the same revenue was screwed out of the country as before. The tax

was levied so as it had never been levied before, and with atrocious cruelty. The people at last deserted their villages, and became robbers; for what the famine had spared to them, the superabundant harvests of the three next years swept away, the prices of grain falling to nothing, while the revenue was demanded in money. One considerate collector positively required payment of the arrears of the famine year, at the price ruling in that extremity, when rice was again selling at one rupee per maund. We doubt if any more cruel or discreditable story exists in the annals of civilised rule. The result was that the collections were "violently kept up to the standard," as Hastings wrote, and the whole country was demoralised and destroyed in the process by which it was accomplished. The propriety of stopping all recovery of rents at such a season as this, and all recovery of opium and other advances, deserves serious attention. Had we done so in 1865-66, we should have taken the edge off the famine. The measures really vital are, it seems to us, the remission of the land revenue boldly, and on the proper scale, throughout the afflicted districts. This includes, in our judgment, the suspension of all recovery of rent, and possibly of all recovery of Mahajun advances on crops, but certainly the suspension of all claims for opium advances for the year, also the importation of rice from Burmah, and wheat from other distant markets. It is emphatically affirmed that the most effectual relief Government can afford in such calamities is timely and adequate remission of the land revenue. During the Orissa famine, in 1866, the belief was acted upon that the State neither could nor ought to do anything. The people were accustomed to being starved, wrote one collector, and must be left to pull through as they could. Relief works were not opened till June, 1866, and food-centres not till July. The Board of Revenue struck the key-note of this lamentable policy as early as the 28th November, 1865: "Government can do nothing even if famine come, but must leave all to private charity."

WAGES AND PRICE OF FOOD.

Wages in money seem to have undergone little or no change for the last twenty years, while prices have risen heavily. In ordinary years the ryot feeds his labourer out of his own grain stores; in dearth he cuts him adrift. Masses, moreover, of the ryots themselves seem to be little better off than day-labourers.

The ryots will work day and night to irrigate their lands where water is procurable; and if we want a rubbee crop, the way to get it would be, we think, to assure the ryot that whatever he might sow, that he, and no other, should reap.—(Extracts from *Indian Economist*, 1874.)

FAMINES AND TAXATION.

(Discussion, East India Association, 1874.)

NATIVE OPINIONS.—MR. CAMBAMPATRI MEENACSHAYA.

In an agricultural country like India, where trade was not fully developed, taxation really meant the compulsory sale of the produce of the country; and an increase of taxation meant an increase of that compulsory sale; for the taxation had been increased, not by the natural progress of the country, but by the imposition of new items and increased rates. The result was, that famines came more frequently. If for nothing else, at least for pity of those dying millions, serious consideration should be given to the land revenue of India; for it kept the people in poverty and degradation, and was the true cause of calamities like the present. It was not necessary to inquire into other causes to ascertain why India is not progressing. The weight of taxation had a most important bearing on the subject. There was the undeniable fact that famines had become almost the normal condition of India. From 1861 to the present year there have been no fewer than four famines, and from three and a half to four millions of people have been destroyed by them, by sheer want of food. That this should occur whilst the country was governed by a ruling nation, the wealthiest in the world and the readiest in resources, was creditable neither to the magnanimity nor the greatness of England. The land-tax of India is the root of the evil.

MR. NOWROZJEE FURDOONJEE.

The taxation of the country was so heavy, that the calamity, when it came, was greatly intensified by that circumstance. And about that there could be no question to any one who would examine the facts. In a very recent letter from the Calcutta correspondent of the *Times*—a writer who would not hastily adopt wrong conclusions—the following remarks occur.—"There is no impost in which the elements of widespread political danger lurk so dangerously as in the periodically increased land-tax. The Oude rebellion taught us the political,

and the famine of 1860-61, as well as 1866, the economic dangers of a system which upheaves native society every thirty years, or more frequently, that the State may allow to the cultivating classes an ever-narrowing or never-increasing margin of subsistence." Could anything be more clear than that a cultivator earning a pittance like that, and crushed by an enormous percentage of taxation, must be a ready victim to famine? Miserable as was the ryot's lot in the best of times, the taxation intensified his wretchedness, and left him without a remnant of protection against the approach of famine. It therefore behoved the government and the people of this country to take these facts into consideration.

SERMON BY THE BISHOP OF MANCHESTER.

(Cathedral, Manchester, 29th March, 1874.)

The question may be asked, "What have we done for India?" India has been the nursery of great soldiers, administrators, financiers, statesmen, yet even to this hour she has hardly been governed with higher aims than as a field in which cadets of English families may push their fortunes, or as a market in which English merchants may with advantage sell their wares. . . . I quite admit the value at such a crisis of any expression of national sympathy. I do not even depreciate the importance in the eyes of India of the £60,000 which the Lord Mayor has sent out from the Relief Committee at the Mansion House to the Relief Committee at Calcutta, and yet one cannot but ask oneself the reasonable question, What can £60,000 do? My opinion has always been that the nation, as a nation, has an obligation and has a responsibility to India, and that the nation, as a nation, ought to show it. What is the power given to the Indian Government to borrow £10,000,000? I ask you to listen to what Mr. M'Cullagh Torrens said in the House of Commons on Friday night. He said, "The country has fallen into the mistake of supposing that by this bill we were financially helping India. The truth was, we were not helping India in the slightest degree. This was not a famine bill, but a finance bill. Its object was to enable the distressed country to borrow in one market cheaper than it could in another. This, no doubt, was a praiseworthy act, but it ought not to be classed in the category of philanthropic proceedings. . . . . Are the reins of empire to slip from our feeble and unworthy hand, or shall we brace our energies, and renew our strength, and rise,

God helping us, to a higher conception of our duties as one of the sovereign peoples of the world?—(*Manchester Guardian*, 30th March, 1874.)

BENGAL FAMINE PICTURES IN 1874.

(Letter of the Chief Magistrate of Tyrhoot, 19th March, 1874.)

I am in charge of the south-east portion of the Tyrhoot district—a track of six hundred square miles in extent. I have six European and several native magistrates under me, and a very great number of subordinate native officials; but every one of them is required for the work. Many deaths from starvation have already occurred, and probably more are occurring in places which we have not yet been able to overtake. One sees starvation in all degrees, but the saddest sights of all are the little children and young men, among whom one sees a degree of emaciation which you could not believe possible—literally skin and bone. One man was found lying in the compound when I got up on Sunday morning He had just strength to crawl to the place. He was quite a young man, but a perfect famine picture, every bone seeming almost to protrude through the skin. He said he had had nothing to eat for eight days, and I quite believe it. He was so far gone that I did not venture to give him solid food at first. I administered a little whisky toddy, which seemed to revive him somewhat, and under careful tending he was beginning to pick up, but last night a sad accident happened. The thatched hut in which he was lying caught fire, and he was burnt to death. Tragedies like these would make a great noise at home; but so many horrible things happen here that they create little sensation. In one of the circles in my subdivision a little girl was found who had apparently been abandoned by her parents. She had been attacked by jackals, and was still alive, but has since died. Village fires, which consume generally the greater part of the village, are of daily and nightly occurrence, and add much to the distress of the people. A good number are often caused by incendiaries. This last week, in six days, I saw five villages on fire. On Thursday last I had just got in from a long ride about two o'clock in the afternoon, when an alarm was raised that a village, a mile and a half from my camp, was on fire. I saw the flames rising, and got on my horse again, and galloped off to it. I came back as black as a sweep. Next

day, about the same hour, a man came running to me with the news that another village was on fire. I was on my horse and off at once with an indigo-planter. Profiting by the experience, we began pulling down houses well ahead, and managed to save the greater part of the village.—(Extracts, *Times*, April, 1874.)

Men, women, and children still swarm to the relief-works. In the Mudhobanee subdivision at least 175,000 people are employed—a fourth of the population, that is to say; and there can hardly be less Durbunga way. The most hard-hearted sceptic cannot doubt now that distress is widespread. It is being felt even by the higher castes and people comparatively well-to-do. There have been many deaths from starvation, I am sure. Only three days ago I saw the corpse of a man—a skeleton rather—lying in the middle of a newly made road, and I managed to fish out the man's wife and children. If I had not, I am sure they, too, would have been dead before another day had gone by. There is a man dying within five minutes' walk of me now—of diarrhœa it will be reported, probably; but since he lay for nearly three days and two cold nights under a tree without food, I should be inclined to say that starvation will be the real, if not the immediate, cause of his dying. I give these two instances as of late occurrence, but I could give many more in which there is, likewise, all but positive—*i e.* all but professional—proof. I cannot conceive how men with their eyes open can ignore such things.—(Tirhoot, 25th March, 1874.)

STATEMENT OF UNDER-SECRETARY OF STATE.

It seems scarcely credible to Europeans that the failure of one crop over an area as large as that of England, Scotland, and Wales combined, and far more densely populated, should spread famine over the length and breadth of that district. The Indian Government had asked the Imperial Government to authorise the building of steamers, and ten had been ordered. These would be carried out in sections by the Suez Canal, each having a carrying power of twenty tons, while it was proposed to send out with them five barges, each carrying sixty tons.—(Extract from Speech in the House of Commons, March, 1874.)

EXTRACTS FROM THE "DAILY NEWS" SPECIAL CORRESPONDENT, MR. FORBES.

SCENES ROUND RELIEF WORKS.

The people crowded in upon the horses quite regardless of the risk of being kicked or trodden on, imploring with clasped hands, shouting at the top of their voices, whining piteously in feeble accents, some of the women weeping silently. But it was in the ranks of the carriers of earth from the excavators to the road, that the misery was apparent Numbers were thus after a sort engaged, the employment of whom in even a pretence of labour was at once a cruelty and a farce. These wretches were fitter for an hospital, wherein their food should be brought to them, than to be at large for any purpose, far less to be engaged in nominal employment for the wage of which, even if regularly paid, a struggle is necessary; but least of all to cling on to a precarious life while unrelieved by the payment of subsistence money for four days at a stretch. Why, I was asking myself, should the payment of all this multitude be charged upon two men when ten payment counters would be none too many? Here, were 7,000 persons engaged on a road without a single individual in authority. As we rode backward, not humanity so much as keen apprehension lest death should be beforehand with us enforced the selection of about half-a-dozen of the most wretched of the wretched creatures, whose cries dinned into our ears, and whose aspect thrilled us with horror. Mr. Henry dismounted, and instructed the paymaster at once to pay the people whom we had brought down their four days' pay, and let them go and seek food. Then the throng became a mob, swaying, heaving, clamouring, struggling. In vain did the chuprassies with their sticks try to force a passage for the paymaster. The press was two great. Wolfish eyes strained hungrily at the handful of coppers; and among the sticks of the chuprassies there waved aloft thin brown arms and hands that were like vultures' claws. There came a rush, and the pice were jerked from out the grasp of the baboo, and fell scattered among the dust, prone upon which plunged men and women and children, and scrambled, hustled, scratched, and snarled for the fourth part of a farthing. Some of the labourers, mad with hunger and the sense of wrong, had entered the bazaar, and sacked the

shops of several of the grain-dealers.—(Letter, dated Durbungah, 20th February, 1874.)

INCREASE OF CRIME.

Mr. Macdonald, magistrate of Durbhunga, reports: "There has been a very great increase of crime, which is certainly owing to famine; people seem willing to go to gaol, as they are sure to be fed there. The people are severely pinched. Cases of child-desertion are commencing and women are bringing their children to me, declaring that they cannot support them, and asking me to take them off their hands. The people are approaching that limit beyond which they cannot procure food, they are obliged to search for roots, and such substances, to eke out their one daily meal."

THE FAMINE IN TIRHOOT IN 1866.

The north-western section of the subdivision of Seetamurhee is that part of Tirhoot in which the ravages of the famine of 1866 were the most terrible. The wider-spread calamity in Orissa threw into the shade the Tirhoot famine of that terrible year. Mr. Robert Wilson was living then at Purhiar factory, in the very heart of the famine-stricken area. The people died like flies all over the place. In a little plot of land close to the feeding-place of the factory, Mr. Wilson used to find from ten to twenty corpses every morning. Stronger women drowned the weaker for the sake of the pittance of food the latter were carrying away from the factory cooking-place, and it became necessary to insist that those who were fed there should eat their allowance on the spot. Unquestionable cases of cannibalism were forced upon Mr. Wilson's observation. Whole villages were depopulated, and the district to this day is but sparsely inhabited, owing to the mortality in the famine year. The air was heavy with the effluvium of decomposition, and there are fields which are now fertile because of the number of bodies buried in them. Great as was the mortality among the labouring classes, they were not the heaviest sufferers. The factory distributions of cooked food kept life in many, and caste prejudices were thrown off that life might be saved. Mr. Wilson must be taken as well acquainted with the condition of his neighbourhood, and his opinion is, the pinch this year will not be very severe here.—(Extract from letter of *Daily News* Commissioner, dated Poopree, 26th March, 1874.)

A FAMINE WALLAH.

I met a "famine wallah" this morning. He has been here for about a month, ordered urgently to a duty which hitherto has consisted in twiddling his thumbs. But he has got an appointment at last. The collector has brought back word from the Commissioner at Patna that my "famine wallah" is to be "district grain officer," that is, that he is to concern himself with the contrivance of "galahs," in which to store the grain as it comes into the station, and to keep the accounts of its subsequent distribution. The tools of this his new craft have been handed to him in the shape of a couple of "Papers of Instructions," the main characteristic of which appears to be that the one flatly and categorically contradicts the other. Lord, Lord! neither papers of instructions nor minutes of objections will fill the bellies of starving thousands. Could any stronger illustration be given of a happy-go-lucky, unsystematic, *dilettante* manner on the part of the authorities in dealing with a responsibility so vast?

ERECTING TELEGRAPHS IN FAMINE DISTRICTS.

Major Mallock had promptly begun the line, and about six miles of it had been completed on the day previous to my ride. But what I saw was not the construction of a telegraph line. The bamboos were being pulled down, and the wire was being coiled up. The line had been countermanded after its construction had been so far advanced, and it was now being dismantled. The bamboos and wire were carted off across country to be used in the Durbhunga line, and the natives in the Tajpore road were free to wonder at the eccentricity of their white masters in putting up poles and wire one day for the sake of pulling them down the next. But the instructive little story does not end here. Just as the removed posts and wire had been brought into use on the Durbhunga line, there arrives the countermand of the countermand. The line *viâ* Tajpore to Chumpta Ghat is, after all, to be carried out, that is to say, if a countermand of the countermanded countermand does not come to hand when the first six miles shall have been a second time erected.

The truth is that Britons appear to lack the faculty of prompt and comprehensive organization.

SELECTING NEW WORKS.

Mr. Anderson is still selecting new works in Mudhoobunee; he has no office here, and nobody knows where he is to be found. His assistant, Lieut. Wright, is absent elsewhere on similar duty. This Durbungah road relief work is specifically entrusted to the charge of Sergeant Butler, of the Engineers; but the sergeant is not here, and is reported to have been ordered to Mozufferpore on special duty by superior authority. I learn further that work, and of course wages, have been recently stopped on this undertaking for two days, for want of skilled men to mark out the line of road. I would ask how these particulars read along with the following injunction, which I find in the Government Code of Rules for Public Works in famine time:—"Frequent inspection of the work and workpeople should be made. Payments of cash on relief works should be made daily, and not at longer intervals." At the credit of the executive engineer there lie in the Durbungah treasury 10,000 rupees, but the official who should sign the drafts is out of the way, and no arrangements have been made to take effect in his absence.

WANT OF APPLIANCES FOR LANDING GRAIN AT BUNKA GHAT.

They would have effected the erection of a stage along which vessels might lie, and be rapidly discharged by the use of a travelling crane working from the wharf. At present, the laden coolies have to scramble along planks communicating with the ships, and there have been accidents attended with loss of life through falls. On ascertaining that there was no draught of water inshore for the large flat or the steamer which tows her, they would have contrived a jetty running out into deeper water and supported by moored boats. At present the flat has to be discharged in midstream into craft having less draught of water—a course entailing great extra labour and no small delay. I cite only a few examples of what might have been done to facilitate the work, had time been taken by the forelock, and had the preparation for the transport requirements been commenced on a comprehensive and systematic scale, concurrently with that recognition of an inevitable famine, under which the Government of India felt it incumbent to enter the foreign market as a purchaser of food grains.

COMBINED IRRIGATION AND NAVIGATION CANALS FOR ALL INDIA.

THE RAINFALL IN INDIA.

THE conditions of rainfall in India are very different from those in England or in Europe generally. There the crops are matured by rain received during the entire length of the period they are under growth, and, accordingly, there is no month of the year in which rain may not be expected. But a totally different state of things prevails here. Virtually, and for all practical purposes, there are but two kinds of weather. A bright, hot, unclouded sun, or unremitting rain for days or weeks together. The rain, moreover, comes only during certain few months of the year; and if it fails to come then, there is an almost absolute certainty of a drought in the country until the return of those same months in the following year. Heavy rain, except perhaps in a single short downpour, or at most for a day or two, can no more be expected during the dry months of the year than snow can be expected in the south of Europe during summer. But in addition to its periodicity, there is another remarkable characteristic regarding the rain in this country.

SOUTH-WEST MONSOON.

The supply for the Madras Presidency is received at a totally different time of the year from that during which rain is pouring over the more northern parts of India. The south-west monsoon usually begins early in June and may be said to close in September. During these and the intervening months irrigation is being carried on vigorously in other parts of the peninsula, but the Carnatic is then parched up under a hot sun and by a scorching wind.

NORTH-EAST MONSOON.

The Madras Presidency has to wait for the filling of her tanks till later in the year, for it is not before the middle of

October that the north-east monsoon bursts on us, and unless the supply is obtained between the 15th of that month and the middle of December a drought is almost certain. Unfortunately for Madras this duration of the north-east monsoon for two months, or for only half the time of the prevalence of the south-west monsoon, is not sufficient to admit of wet cultivation being carried on by the help of rain only. In two months no crop can be brought to maturity; and it, therefore, becomes necessary to store water so that the supply may be eked out gradually for a much longer period. On this account it is that in no part of India do we find so many tanks as in the south. And it is, no doubt, the very fact of the people of Madras having been driven by necessity to store water which has taught them so well the subject of irrigation.

DIFFERENCE BETWEEN THE TWO MONSOONS.

Thus, then, the short duration of the north-east monsoon, so far from having retarded irrigation in Southern India, has, on the contrary, given an immense impetus to its development, and, if the difference between the two monsoons were one simply of duration, irrigation could be carried on just as successfully in one part of the country as in any other. But the two monsoons differ in other respects. The south-west monsoon pours down on the western side of India more than twice as much rain as the north-east monsoon does on the Carnatic; and while the former is rarely known to fail, the north-east monsoon fails constantly, and sometimes for two or three consecutive years.—(*Pioneer.*)

NO WANT OF MOISTURE IN INDIA.

There cannot be, where the average fall of rain is much greater than in our own island, but it has this peculiarity, that instead of falling nearly throughout the year, it is supplied in great abundance within a limited period. It falls during four months of the year in such quantities as to be ample for all purposes to which it can be supplied; but if neglected, or allowed to run to waste when in such abundance, the spendthrift's career is soon made apparent, and famine and starvation stare in the face.

HEAVIEST FALLS OF RAIN IN INDIA.

("Indian Irrigation," by Lieut.-Col. C. W. Grant, of the Bombay Engineers. London, 1854)

SHORES OF WESTERN INDIA.

	Height.	Rain (ins.)
Mahableshwer	4,500	248
Attagherry	2,200	170
Shandalla	1,740	168
Untraymalley	6,000	164
Dapoolie	1,200	138
Angara Shandy, M. Coast		124
Cannannore		121

EASTERN INDIA AND BAY OF BENGAL.

	Inches.
Cheerapoor	610
Syllet	209
Tavay	208
Maulmain	189
Sandowy	178
Akajah	155
Darjeeling	125

ORISSA FAMINE COMMISSIONERS ON RAINFALL.

The following table shows approximately, so far as we can gather from very imperfect information, the average annual fall of rain in inches in different districts or places, from which the advantage of monsoon irrigation may be gathered:—

Place.	Rainfall.	Remarks.
Delta of the Cauvery	30 to 35	The greater part of the fall is in the north-east monsoon in October and November.
Madras	30	
Godavery and Kistna Deltas	40 to 45	These districts share partially in both monsoons.
Orissa	55 to 65	Most of the rain falls in the south-west monsoon, but there is generally a considerable burst in October and often some rain in November
Western Bengal	55 to 65	
Calcutta	69	
Districts east of Calcutta	70 to 75	
Eastern districts of Bengal	90 to 110	
Eastern Hills	450	
Behar	45	The chief fall is from June to September.
Benares	40	
Allahabad	38	
Agra	27	
Delhi	23	
Ferozepore	16	Monsoon fall is extremely uncertain.
Lahore	18	
Peshawur	14	Most of the rain falls in spring.

Local registers of the rainfall should certainly be kept at as many places as possible.

FALL OF RAIN, BOMBAY—THIRTY YEARS' AVERAGE.

Months	
January	0
February	0
March	0
April	0
May	0
June	22 13
July	24 88
August	16·77
September	11·05
October	1·25
November	0
December	0
Total average, thirty years	76·08

RAIN IN N.W. PROVINCES.

(By Col. W. H. Greathed, R E., C.B , Chief Irrigation Engineer, N.W.P.)

The rain-clouds of the south-west monsoon seem to travel up the Ganges, and reach the North-Western Provinces about a fortnight after rain has fallen at Calcutta. With the first downpour the season of agriculture commences. Crops are liable to fail if the commencement of rain is too long deferred, if it fails, or if the fall is not distributed over a sufficient number of days. The uncertain crops of the rainy season are Indian corn, and millet of various kinds, which form the staple food of the agricultural labouring classes. The rainfall in Hindostan of the winter or north-east monsoon is everywhere less than in the summer. It is most felt on the eastern coast, from Madras downwards, and in Ceylon it is very copious. On the western coast the only considerable winter rain is between Cannannore and Vingorla. As in the south-west monsoon the rainfall of the north-east monsoon diminishes in the valley of the Ganges as the distance increases from the sea, and becomes very light in the North-Western Provinces and the Punjab, where it is due at Christmas. If the winter rain is favourable, the barley and wheat has a fair chance: but on unirrigated lands the winter crops of cereals are always uncertain. The richer crops, sugar, indigo, &c., which require water throughout the hot season, are entirely dependent on artificial irrigation. The drainage area of the Ganges is 11,200, that of Jumna 7,800 square miles. Their greatest floods occur in July

or August, and are respectively 230,000 and 160,000 cubic feet per second. In October the waters diminish sensibly, and by the middle of January they fall to 4,000 and 2,000 feet, at which they continue till the end of March, when they are enlarged by the melting of snows on the mountains, and thenceforward continually expand until supplemented by the south-west monsoon. Unfortunately, the period of lowest supply is that of greatest demand.—(Extract from a paper, read before the Institution of Civil Engineers, 1873.)

COLONEL SYKES, M.P., ON INDIAN RIVERS AND RAIN.

All the great rivers that come into the Bay of Bengal originate in the Western Ghauts, except those which originate near Candeish, the Tapty, and the Nerbuddah. They run to the west, while all the others run south-east The Godavery, the Beema, Kristna, and others, run in a south-easterly direction to the Bay of Bengal. It is a remarkable fact with regard to the amount of rain which falls on the coast, that the amount diminishes with the latitude from the south going north along the western coast of India. From upwards of 150 inches in Tranvancore it diminishes gradually along the coast, being 132 between Cannannore and Goa, 72 at Bombay, and at Kurrachee next to none at all. The reason that there is none at Kurrachee is that the temperature of the air is greater than that of the clouds which pass over Lower Scinde, and they cannot, therefore, be condensed into rain; and it is only when they impinge upon the mountain range of Scinde that they meet with a colder temperature, and the aqueous vapour is immediately condensed into rain, because the air at each degree of temperature can only hold in suspension a definite quantity of aqueous vapour, and any quantity beyond saturation falls in rain.

The fall of rain in different parts of India varies from 8 to 10 inches in Lower Scinde, to 50 feet, or 600 inches annually at Chirra Poonja, at the head of the Bay of Bengal. At Mahabuleshwur, in the Western Ghauts, there has been a maximum rainfall of 400 inches in one year, and along the Western Ghauts generally the rainfall is rarely under 200 inches; while at from twenty-five to thirty miles eastwards of the Ghauts the average is only 25 inches; and as you go further eastward towards Sholapoor, it is even less than that.

The rainfall at Cheaniot is only 4 inches a year. As it

advances to the hills on the parallel of Lahore it is 16·24; at Sealkote it is 30 inches, and at Jummoo it is 60.

CRITERION OF ARTIFICIAL IRRIGATION.

Irrigation is a necessity for a large section of British India, is of incalculable importance to the cultivators over a still larger area, and is unnecessary only in two limited bands of territory, where the rainfall is excessive.

In the north-west corner of India there is an arid region, including all Sind and half the Punjab, where the normal annual rainfall is less than fifteen inches. Here irrigation is essential to the existence of the people. Next, there are two zones of dry country, with an annual rainfall between fifteen and thirty inches. One surrounds the arid region on the north and east, in a belt from one hundred to two hundred miles wide, and has been named by Dr. Brandis the Northern Dry Zone; it includes Delhi and Agra. The Southern Dry Zone is in the peninsula, extending from Nasik to Cape Comorin, at a distance from the two seas. These dry zones also stand in absolute need of irrigation. The next region has a rainfall between thirty and sixty inches, and includes the upper part of the valley of the Ganges, Central India, and the eastern coast of the Madras Presidency. Here irrigation is also much needed, and great distress has been caused by the want of it. The fifth region has a rainfall between sixty and seventy-five inches, and comprises the deltas of the Mahânadi and Ganges and the lower part of the Ganges valley. In this more favoured belt, irrigation may be looked upon as a luxury, often useful, but not absolutely necessary, except in extraordinary years. Finally, there are two belts of excessive rainfall, where irrigation is unnecessary, the one extending from the mouth of the Irawadi, along the east coast of the Bay of Bengal, up the valley of the Brahmaputra, and along the skirts of the Himalaya, and the other along the west coast of the peninsula, from the sea-shore to the summits of the ghauts.—(B. B., Progress Report of India, 1873, p. 37.)

REMARKS BY COL. F. H. RUNDALL, R.E., CHIEF ENGINEER, BENGAL IRRIGATION DEPARTMENT, 1869.

In Orissa the rainfall reaches 60 inches. In 1865, the year of famine, nearly sixty inches were registered at Cuttack; but

the rains ceased on 14th September; the crops consequently perished.

The actual quantity of rain falling during the year is therefore *no* criterion of whether artificial irrigation is necessary or not. It is the regularity or otherwise of its distribution during the cultivating season which has to be observed.—(November, 1869.)

RAIN-GAUGES AND STORAGE RESERVOIRS.

It will be necessary to establish rain-gauges at different points over the catchment basin of the valley from which it is intended to obtain the supply; and daily observations of these gauges must be taken for comparison with a series of simultaneous observations taken and recorded at the nearest station at which the rainfall has been regularly and carefully noted. It is evident that a comparison of the several observations taken over the area of water-shed with those registered at the permanent station will convey a just estimate of the amount of maximum and minimum rainfall that may be relied upon.

The two main questions that it is proposed to submit for consideration are, first, *the selection of a reservoir site, and the leading principles to be observed in the designing and construction of storage works.*

The purposes for which the work may be required will, of course, affect materially the choice of a position, as well as the details of the structure itself, but certain general principles are available for our guidance in every case, after considering which, it is proposed to dwell upon such points as apply to the special purposes for which reservoirs may be constructed.

The first and most essential point for accurate determination by the engineer is undoubtedly the amount of rainfall, both maximum and minimum, that may be expected in the district under examination, and, having arrived at reliable data on this point, the next consideration will obviously be, what amount may be made available, due allowance having been made for evaporation and absorption.

RAINFALL AND FORESTS.

(By W. G. McIvor, F.R.G.S., Superintendent, Government Plantations.)

One result of felling forests for chinchona cultivation on the Neilgherries has been to establish the fact of the immediate

and greatly increased supply of water in the adjacent streams. This result being contrary to received opinions, and also to anticipation, led to a series of careful observations which establish beyond doubt, that when a forest on the hills is felled, the volume of the water in the streams, rising in, or receiving their supply from, the land occupied by the forest, is increased more than twofold. As this increased flow of water has now been permanent for five very dry years, it cannot be the result of any accidental peculiarity or circumstance. Both from a scientific and practical point of view this is a very interesting fact, as showing an extraordinary and fundamental error in an accepted theory. Bearing in mind the fact that trees exist upon moisture, and have been produced by moisture, the inference is plain that they are of necessity consumers, and not producers of the moisture of the land in which they grow, and this apart from the great quantity of water which they draw from a depth in the soil, to be evaporated by the leaves and dissipated in the atmosphere. Another great fact attendant upon the production of forests seems to have been overlooked, namely, that it requires more constant and uniform moisture to support a seedling than is necessary to maintain a full-grown tree.

Practically this question is one of great moment, inasmuch as it shows that the existence of trees at the sources of springs and along the banks of streams greatly reduces the flow of water. The trees are in fact so many pumps continually at work drawing up the moisture and dissipating it in the air, converting the residue in the shape of elaborated juice into their own substance. A tree 45 feet high and covering 100 superficial feet, throws off at at least six cubic feet of water every warm and dry day. An acre would contain 433 of such trees, but reduce this number to 300, and it gives a daily evaporation from every acre of forest of 1,800 cubic feet, or the enormous quantity of upwards of 11,000 gallons. Yet incredible as this may appear, it does not represent one-half the moisture thrown off daily by an acre of forest on the Neilgherries, during the months of January, February, and March. In each year our average number of warm and dry days exceeds 190, but reduce this number to 150, and we have upwards of a million and a half gallons of water extracted from the soil and dissipated by every acre of our forest land.

This result must be intensified in the plains where the heat

and number of dry days are greater. This may, however, explain the alleged fact that the felling of forests there has diminished not the water supply in the ground, but the rainfall. During the dry season the evaporation from the sea is carried by a steady southerly breeze over the plains towards the line of the Himalayas. The great evaporation from the leaves of a large forest in the plains must cool the overhanging strata of air. The moist sea air entering these colder strata, it is imagined has a portion of its moisture condensed, and a certain amount of precipitation thereby obtained. When the forest is felled and thus ceases to cool the overhanging strata of air, the sea cloud will pass over its site without condensing, and thus the local rainfall will be diminished. Theoretically this is good reasoning, but practically the conclusions drawn therefrom are not well confirmed. This appears to arise from the cold produced by the evaporation of foliage being immediately absorbed and carried away in the surrounding heated atmosphere, without cooling it sufficiently to cause precipitation.

It is well known that over the arid plains of Peru an upper stratum of air charged with sea moisture, continually floats forward towards the higher ranges of the Andes, where coming in contact with the cold air of the hills the moisture is precipitated, returning to the sea in copious rivers. The ancient Peruvians, with a skill and perseverance worthy of imitation by our civilised Government, diverted the waters from the Andes in covered channels, over the whole of their barren country, causing Peru from the Andes to the sea to teem with luxuriant vegetation. Over the rich fields of corn, and verdant fruit gardens, waved the lofty palm; these, combined, presented an evaporating surface of foliage, of hundreds of thousands of square miles, and in addition to this the evaporation from the moist surface of the land. This evaporation no doubt greatly cooled the atmosphere, but all to no purpose, for this vast expanse of vegetation did not wring one drop of water from the upper stratum of air, which still hurried on to be condensed in the cold atmosphere of the mountains.

The practical effect of the enormous evaporation from trees is very apparent in the springs and streams on the Neilgherries. When trees are planted on the watershed and near the source of a stream, the water dries up. When a water channel is conducted round a barren hill, trees spontaneously spring up on

its banks. While all springs arising in, and all streams passing through, valleys destitute of trees maintain their flow throughout the dry season far better than those which arise in, and pass through, wooded valleys, it being obvious that the roots of the trees intercept and drink up the water in its descent through the soil to the streams. The foregoing favours the opinion that, if our mountain tracts were destitute of forest, the streams in the dry season would carry to the low country a much greater flow of water than they do at present But the great advantages which trees bestow cannot be overlooked. They improve the soil on which they grow, render the temperature more equable, reduce the violence of storms, afford shelter and shade very grateful to man and beast, while their presence gives a pleasing effect to the eye. These advantages, apart from their economical uses, require (so far as is consistent with general cultivation) the presence of as large a number of trees in every locality, where they can be produced, as may clothe the bleaker and less productive areas.

RAIN, AND WHY IT IS MEASURED.

The rainfall has not engaged the attention of the State to the extent that its importance demands. This should not be; a great inquiry, having for its object the improvement of the wealth and health of a nation, ought to be provided for out of the public money ungrudgingly.

The facts developed by the rain gauge have the most multiplied and remarkable practical as well as theoretic relations. They concern agriculture, climate, and public health, and are the most indispensable data to the hydraulic engineer engaged in great works of irrigation and drainage, and in the supply of water to cities. It is a branch of observations that must be pursued at very numerous points, and it is only by the collection of immense masses of such observations that the average or general rainfall for any large district can be obtained, or the limits known, above or below which the oscillation of the average may reach in a series of years.

Observations to be combined into a System.—Ignorance of what affects so powerfully the health and comfort of populations, the fertility of the soil, the purity and temperature of the atmosphere, the prosecution of many of the arts of life, the operations of engineering and drainage, and much else, can be

remedied by careful and prolonged observations made simultaneously at many points. Results thus separately obtained must be combined and elaborated into system before they can yield the harvest of benefit to mankind.

Disguise it as we may, whether we take water from the roadside spring, the well, the brook, or the river, it is but rain, and on the amount of rain the water supply depends.

It will not be safe to rely upon always obtaining the mean fall, and therefore the calculations are usually based on the mean fall in three successive dry years; this is about eighty per cent. of the true mean. The next question is the amount of evaporation, also the porosity or otherwise of the soil, and on the nature of the vegetation.

One inch of rain, over an acre of ground, weighs 101 tons, and amounts to 22,623 gallons; therefore, with 28 inches of rain, each acre yields 28 inches × 22,623 = 633,444 yearly.

What constitutes a Wet and a Dry Season.—Capricious as the wetness or dryness of different years appears, the laws and limits of these departures from the mean annual fall are apparently very near solution. The following rules are good approximations.—

The fall in the driest year will be one-third less than the average. The fall in the wettest year will be one-third greater than the average. Therefore the fall in the wettest year will be double that in the driest year.

The relative wetness of different months is a point also of very practical importance. Of the greatest fall in twenty-four hours our knowledge is still very limited; but some striking results have been obtained.

The Humidity of the Air.—The rain-gauge is indispensable in determining the relative humidity of different places; but it should be accompanied by the hygrometer, now so simple, so certain, and so cheap; but it must be placed under similar conditions in all places, or the results will not be comparable. The hygrometer (moisture-measurer) consists of two identical thermometers suspended on a frame; the bulb of one is covered with a thin piece of muslin, to which a small cotton wick leads a supply of water, the other thermometer is uncovered. According to the humidity of the air will be the rate of evaporation, and the faster the evaporation the more will the wet bulb be cooled; and therefore the greater the difference between the dry and wet thermometers, the greater the dryness,

of the air. All interested in this matter should obtain Glaisher's Hygrometric Tables.

In Great Britain a list of upwards of a thousand stations, with the observers' names, the size and height of their gauges, the amount of rain, and the number of days on which 0 01 inch had fallen in the previous year, is also annually published in "British Rainfall." In England there are gauges from Penzance to the Scottish Border, all through Scotland and the Orkneys, even to Shetland. Westward there is a station at Foilhammeram, in the island of Valentia, and eastwards our limits are the coast-line at Lowestoft. In connection with water-marks there are gauges amid the most beauteous Scottish lakes.—(G. I. Simon's "Rain: How, when, where, why it is Measured." 88 pp London: E. Stanford.)

THE PRESENT SYSTEM VERY DEFECTIVE IN INDIA.

(Official Report, 1871.)

The efforts of the scientific officers interested in meteorology are being devoted to the introduction of a more systematic treatment of the subject than has hitherto been attempted. The observation of the rainfall of Bengal is conducted by Mr. Blanford; he classifies his stations in ten groups — four in Eastern Bengal, three in Central Bengal, and three in Berar and Orissa. In Madras, new and accurate rain-gauges have been supplied to two hundred and sixteen revenue stations. The meteorological establishment in this province has now been in existence for two years, under the charge of Mr. Pogson, and is in fair working order. Mr. Chambers, the superintendent of the Government observatory at Colaba, has submitted a report describing in detail the existing arrangements for the record of meteorological observations in the Bombay Presidency, and offering suggestions for their improvement and extension. His suggestions are generally in accord with those of a writer in the *Calcutta Review* for April, 1871, who, after stating his opinion that our knowledge of meteorology in India is actually but little in advance of its condition twenty years ago, condemns the present system of having an independent reporter in each Government to carry out a scheme without reference to any general plan, and points out the necessity for concentrating the management in the hands of one qualified chief, in order to remove most of the causes of imperfection and failure. Such a director or superintendent would be for the

whole of India, and would bring together and discuss results. The reviewer ends by pointing out the great importance of India as a region of meteorological observations.—(Moral and Material Progress of India. 1870-71. P. R. 230.)

SUBJECT UNDER CONSIDERATION STILL (1873).

(Official Report, 1873.)

Indian administrators are *beginning* to be impressed with the great importance of meteorological observations to agriculture. The question of placing the whole system of registration under one head, and, by introducing uniformity throughout India, of utilising the combined work, *is still under the consideration of the Government.*—(Extract from B. B., "Progress and Condition of India," 1873, p. 26.)

RAINFALL IN INDIA, IN INCHES.

(From *Statistical Reporter*, 1874.)

ARRACAN, EASTERN BENGAL, & ASSAM.	Inches
Sandoway	236
Akyab	209
Chittagong	105
Noakhally	101
Tipperah	93
Cachar	119
Sylhet	154
Cherra Punji	523
Shillong	77
Seebsaugor	94
Nazeerah	86
Tezpore	76
Nowgong	87
Gowhatty	70
Goalparah	98
ORISSA AND PLATEAU OF WESTERN BENGAL.	
Pooree	55
False Point	74
Cuttack	54
Balasore	67
Midnapore	62
Contai	74
Bancoorah	52
Raneegunge	54
Soory	51
Purulia	44
Hazareebaugh	50
Ranchee	43

RAJPOOTANA, BUNDELKUND, & NERBUDDA VALLEY.	Inches.
Nimar	39
Hoshungabad	46
Nursingpore	44
Jubbulpore	53
Sagor	50
Jhansi	34
Ajmeer	22
GANGETIC DELTA & NORTHERN BENGAL.	
Mymensing	103
Dacca	74
Bogra	88
Rungpore	88
Dinajpore	84
Maldah	53
Rampore Beauleah	61
Rajmehal	50
Furreedpore	75
Berhampore	54
Jessore	66
Kishnagur	56
Burdwan	59
Calcutta	66
Saugor Island	82

GANGETIC PLAINS (BEHAR & NORTH-WESTERN PROVINCES).

	Inches.
Bhagulpore	48
Monghyr	40
Gya	43
Patna	37
Arrah	48
Chuprah	37
Mozufferpore	44
Chumparun	45
Benaies	37
Goiuckpore	52
Lucknow	47
Agra	25
Delhi	24
Bareilly	43
Roorkee	39
Umballa	34

CENTRAL INDIA (SOUTH OF SATPOORAS).

Wardah	37
Nagpoie	45
Chindwara	41
Seoni	46
Chanda	48
Raipore	50
Belaspore	42
Sumbalpore	50

WESTERN INDIA (SOUTH OF SATPOORAS).

	Inches.
Bombay	71
Mahableshwar	259
Poonah	26
Satara	38
Sholapore	27
Dharwar	36
Admednuggur	27
Belgaum	50

PUNJAB.

Lahore	15
Shahpoor	11
Rawulpindee	28
Peshawar	11
Dera Ishmail Khan	7
Mooltan	7
Hissar	15
Sirsa	13

HIMALAYA.

Buxa Fort	256
Rungbee	175
Darjeeling	124
Khatmandu	52
Naini Tal	86
Dehra	80
Simla	58
Kangia	106
Hazara	43

UNITED STATES' EXAMPLE WORTH COPYING.

Example of Meteorological Records, published by the United States, of all Stations in States and Territories, every year, in forty pages, the size of this book.

STATIONS.	JANUARY.				FEBRUARY			
	TEMPERATURE.			RAIN.	TEMPERATURE.			RAIN.
	max.	min.	mean.		max	min	mean	
NORTH CAROLINA.								
Goldsboro	61	15	37 0	5·02	85	21	53 3	0·62
Oxford	50	15	30 8	2 69	73	19	46 8	3 30
Raleigh	58	12	31·6	..	79	17	48 4	2·44
Albemarle	58	10	33 1	3 33	77	16	48·5	2 83
Statesville	55	6	29 0	1·96	70	12	44·7	3·00
Averages	.	..	32 3	3 25	..	.	48·3	2 44

OLD NATIVE WORKS OF IRRIGATION DESIGNED AND CONSTRUCTED BY NATIVES.

MADRAS WORKS.

(Extracts from Report by the Chief Engineer, P. W. Madras. 1868.)

In no other part of India had so much been done for the development of the resources of the country by the old native rulers. The further south one goes, and the further the old Hindoo polity was removed from the disturbing influence of foreign conquest, the more complete and elaborate was the system of agriculture, and the irrigation works connected with it. The execution of such works appears to have been considered a religious duty by the people. Not only has almost every available source of supply, within their power of mastering, been utilised to a very great degree, but in many instances they even carried out the works far in advance of the supply. The vast system of tanks which cover the face of the country, and which represent an almost incalculable expenditure of labour, have very generally been constructed not only to provide for the storage of the ordinary rainfall, but also that of exceptionally favourable years.

CONSTRUCTIVE SKILL SHOWN.

Not only, too, were all favourable sites for the construction of tanks eagerly sought for and turned to the best account, but unfavourable sites also, where success was only to be attained by the display of very considerable constructive skill, and by the most profuse outlay of money and labour, or at least of labour. The natives thus constructed numerous tanks with embankments three or four miles long, and thirty to fifty feet high, and riveted on one or both sides with rough stone; with sluices for the distribution of water, and with escapes for the discharge of exceptional floods, some of them of great length and of massive construction. Their sluices are remarkably well adapted for the distribution of the water under a variable head, and are, moreover, eminently calculated to prevent the

occurrence of accidents from the careless and imperfect management under which they must generally be placed. So anxious were the natives to avail themselves to the uttermost of all available sources of supply, that they constructed many tanks in situations where it was impossible that a proper supply of water should reach them, and it is now common to meet with works of the kind which at a later period have been purposely allowed to fall into decay. Other tanks have also been rendered useless by becoming silted up. The process, though very generally a slow one, is nevertheless sure. Of course there are cases where tanks may have given way from neglect, or from their not being provided with proper means for the discharge of surplus water in heavy floods.

NATIVE ANICUTS ACROSS RIVERS.

The natives also carried direct irrigation by means of river channels, or by channels and tanks combined, to a tolerably high degree of perfection. There is the Cauvery system in Tanjore, which is the completest thing of the kind in India, and the Tambrapoorny system in Tinnevelly, which, though on a much smaller scale, exhibits, with regard to the anicuts across the river at the heads of the various channels, very considerable constructive skill. There are numerous works of a similar character on the Toongaboodra in Bellary, the Cauvery and its branches, and on nearly all the minor streams in the Presidency. With regard to the alignment of channels, the natives having only the means of judging of levels where they could see water actually running or standing, failed when they ventured to enter irregular ground. They could not go far wrong as long as they kept parallel to a river, but if a ridge or a succession of ridges had to be cut through they got into difficulties. Consequently there are many old channels which have been abandoned, either because the difficulty of conveying the supply to the required point turned out to be more formidable than had been anticipated, or because the point of delivery may have been on an impracticably high level. On the whole, the native channels are an inferior class of work to their tanks.

DESIGN.

It will be seen from the above remarks that the natives had made great advances towards the attainment of a complete

system of irrigation throughout this Presidency. But though many of their works exhibit considerable boldness of design, and no small degree of constructive excellence, they failed in mastering the largest class of rivers, where no foundation but sand was to be found for the construction of masonry dams. Thus it required the aid of British engineers to construct anicuts across the Cauvery in Trichinopoly and Tanjore, and across various other rivers in the low country bordering on the eastern coast. Once they were finished, but two great works remained to be done. I refer to the construction of dams across the Godavery and Kistna at the heads of the deltas of those rivers, and to the opening out of a system of channels from them.

NEGLECT OF NATIVE TANKS.

As in Nellore and other districts, numerous improvements may be made to the existing tanks Many of them have silted up to such an extent as materially to impair their efficiency; and the attention of the officers of the department may be usefully occupied in restoring the capacity where possible by raising the embankments, when this can be advantageously done without submerging valuable land, or without incurring too great an outlay. No one project of this nature can merit the special attention of the Government of India; but a number of well-devised improvements, which may individually appear insignificant, are what such districts as Bellary, Cuddapah, and Kurnool, and indeed most of the other districts in the Presidency as well, want; for it is by means of them that the existing sources of supply can be utilised to the full extent.—(December, 1868, P. R. 389, 1870, p. 48.)

ANCIENT WORKS FOR IMPOUNDING WATER.

(By Arthur Jacob, B A., Executive Engineer.)

Of these the most prominent examples are undoubtedly to be found in Hindostan, where the magnitude and antiquity of the storage works cannot fail to arrest attention. These great works, surpassing in their immensity what are conventionally esteemed to be the wonders of the world, the productions of other countries and nations, took their origin in the necessities of the people and the variableness of the climate of India, and were, in fact, great public works on which the welfare of the

people mainly depended. The climate of India, although singularly uniform in some respects from year to year, is remarkably variable as regards the rainfall; and in order to guard against the disasters of famine and sickness, inevitably attendant on a scanty monsoon, the native princes were wont to make such provisions as large resources and an almost unlimited power enabled them, in order to obviate the difficulty that they had to contend with. They took advantage, in certain districts, of every nook and ravine, whether large or small, and converted them into storage reservoirs by throwing across banks of earth, or *bunds*, as they are termed, producing, in certain districts, such an elaborate and complete system of irrigation as can only be compared, for cost and completeness, to our railway system in England. Taking fourteen districts in the Madras Presidency where tank irrigation was most generally relied upon, the records of the Indian Government show that there are no less than 43,000 irrigation reservoirs now in effective operation, and as many as 10,000 more that have fallen into disuse, making a total number of 53,000 storage works. The average length of embankment is found to be about half a mile, the extreme limit of the series being a dam of the immense length of thirty miles. This ancient reservoir, called the Poniary tank, is no longer in use, the cost of maintaining such a length of bank in adequate repair having probably been found disproportionate to the advantage derived from the supply. The work, embracing an area of storage of between sixty and eighty square miles, remains however as a record of what the Hindoos are capable of. To quote a second example, there is the Veranum reservoir, now in actual operation as a source of supply, and yielding a net revenue of no less than £11,450 per annum. The area of the tank is thirty-five square miles, and the storage is effected by a dam of twelve miles in length. In order to bring the immensity of this system of storage works within the reach of statistical minds, it has been calculated that the embankments contain as much earth as would serve to encircle the globe with a belt of 6 ft. in thickness. To show that these are not singular examples, one other embankment of remarkable size may be alluded to. This embankment, of somewhat singular construction, was built on the island of Ceylon, and bears testimony that the Singalese monarchs were not behind their neighbours in public spirit or enterprise. The embankment was composed of huge blocks of stone strongly cemented together, and covered

over with turf, a solid barrier of fifteen miles in length, 100 ft. wide at base, sloping to a top width of 40 ft., and extending across the lower end of a spacious valley.

Thus it will appear that the practice of embanking across valleys, for the purpose of retaining the surface water, has for ages been in operation. There is no doubt that the disposal of some of the most remarkable works in India is not what it might, with advantage, have been; the fact remains, however, that the desired end was attained.—("On the Designing and Construction of Storage Reservoirs," by Arthur Jacob, B A., late executive engineer for irrigation, H M. Bombay service; read before the Society of Engineers, and awarded the Society's premium. London, Spon, 1867, p. 3.)

NATIVE LAKES AND TANKS, CENTRAL PROVINCES.

Many have fallen completely out of repair. The masonry *débris* of others in the wild fastnesses of the hill regions, tell their own tale of energy and agricultural prosperity hundreds of years ago where now there is nothing but forests and wild beasts. But, whether in repair or in ruins, they all signify that lakes and tanks have played no small part in the administration of the country during the earlier dynasties. The effect of this can be seen to this day in whole districts which, compared to the North-West, for instance, may be said to be devoid of wells. Even for drinking purposes, the people in many parts depend on tanks, into the waters of which cattle are allowed to go and wallow.

But it is not in the interior alone that these monuments of the past are to be found. If not so large, or useful as the reservoirs in the valleys and plains, the Juma, Aurbajhirri, and Pelingkheri tanks at Nagpore, that at Seoni and the Hunnooman Tal at Jubbulpore, are still extraordinary works of which even a scientific age and a highly civilised government may be proud. It is impossible to take an account of what has been done in the way of providing water-supply by native dynasties in the country now known as the Central Provinces, without being convinced that one great duty of the government of the day is to reclaim the really useful works of the past, before attempting to project new ones. If we can by cleaning out old tanks, removing their silt and repairing their banks, contribute towards a sufficient supply of good water, we shall confer a real

blessing on the people, we shall secure their gratitude; and prove to them that, fully appreciating one good feature of native government, we wish to vie with past dynasties by giving to the people the two absolute necessaries of life—pure air and water. It is not to be doubted, that if the people found us heart and soul in this object, they would aid the British even more cordially than they do now, in the work of improved government.—(*Jubbulpore Chronicle*, "Indian Economist," February, 1871.)

COTTON AND IRRIGATION IN 1788.

March 29, 1788.—The higher grounds, on which the cotton ripens in the cold season, are likewise not without some advantage. The dews falling on the wool, that discovers itself by the elasticity of the capsula, bleaches it by the assistance of the sun, and contributes in some measure to its fineness; but where they have not the conveniency of water to support it in the period when the pod begins to swell, the crop is but poor, and inferior in quality to those that have either a succour by the freshes or are situated lower, where the rains may have more influence.

April 2, 1788.—I proceeded to Onlar district, where the fine red cotton is cultivated, and where I found the planters employed in gathering the few straggling pods of cotton which had ripened since the first crop, and which they are at liberty to appropriate for their own use; likewise they were cutting the thin branches that were formed since first reduction. The plantations that were already accomplished they watered from three large ponds, which I took on my first stay as overflowings by the freshes, and which the planters were not able, or they thought not equivalent to their trouble of levelling; but now I found that they were purposely constructed, and that with great industry, to facilitate the watering of their districts The most of these ponds are situated close to the Dahder and the Myhie, and are embanked above the banks of the river. Some of them were formerly creeks of the river, which they separated by a high wall from the immediate communication with the stream. In the midst of these walls is a sliding sluice, which is opened at the time when the freshes rise, and they shut them again as soon as they have a sufficient quantity of water. From each of these reservoirs are narrow channels made,

with the level of the district, by which the water is led under the earth to the most remote plantation. Each of these channels has its respective sluice, which is hid in the encompassment of the reservoirs, and only discernible at the time when the planters are employed in watering the cotton. As the water comes beneath the mark of the conduit, which was the case with some of these, they have temporary wheels erected, with suspended pots, which are turned by a man.—("Tours of Scientific Research in Guzerat, in 1787-8," by Dr. Hove, a Polish savant. Published from the MS. in the British Museum, under care of Dr. Alexander Gibson, by order of the Government of Bombay. Bombay Government Records, No. XVI. 1852.)

COTTON AND IRRIGATION IN 1869.

By Mr. Rivett-Carnac, late Cotton Commissioner, Central Provinces and Berar)

With a little arrangement, and at a comparatively small expense, these watercourses might, I believe, be utilised for irrigation works; and as it is possible that the importance of irrigation to the successful culture of cotton may hereafter assert itself more positively, I would desire to urge the desirability of an inspection being made, with a view to determine whether a system of irrigation might not be undertaken in the Berars with the prospect of financial success. Captain Meadows Taylor, whom no subject of interest or of benefit to the people of Berar seems to have escaped, mentions that the average cost of watering an acre of ground per year for a crop which requires water for a whole year is about 37½ rupees. This calculation was made some years ago, when cattle and labour were much cheaper; and the expense now incurred by the cultivators of North Berar with their garden crops must far exceed this. Captain Meadows Taylor goes on to mention that, from calculations made, water stored in an artificial lake on the hills could be sold at a profit, so as to supply irrigation at the rate of two rupees per acre per year, and even less. I believe that water can be stored in Berar in such a manner as to enable the people to irrigate crops to which they cannot now afford to give water, but which could be much improved by irrigation. A march through this part of the country will convince any one that its physical formation affords great facilities

for the construction of inexpensive irrigation works, and the remains of masonry met with in some places show that the importance of this subject was duly recognised by our Mahommedan predecessors. In nearly all the old Mahommedan towns are to be found ruins of extensive water-works. Besides wells and *baolees* innumerable, the remains of embankments across streams are in many places visible. Across the bed of the river which flows by Julgaum, is the remains of a masonry work which I think there can be no doubt must have been a dam or *annicut* to store the water of the river during the hot months. The course of a small stream lies right through the town of Jamode, and the Mahommedans took advantage of it to feed a masonry tank, the water of which appears to have been carried by means of pipes for some distance into the town. These works are now utterly out of repair.—(Report, 1868-9, pp. 175-178.)

OUR WORKS ARE AMPLIFICATIONS OF INDIAN IDEAS.

(By Lieut.-Col. Tyrrell.)

I speak with an experience of fifteen years as an executive engineer in many parts of India—in the Madras and Bombay Presidencies, in the Nizam's assigned districts of Berar, in the Central Provinces, and in Oude. India has an engineering history, not written in splendid palaces and lofty structures, yet still marked by works whose usefulness may vie with works of any other nation—works on which her life depends. All over India, but more particularly in the central and southern portions of the Peninsula, works for irrigation and for storing water are to be seen, of greater magnitude generally than we have yet attempted to construct, notwithstanding our boasted science and the ample means at our command. The splendid tank of Hoossain Saugor, near Hyderabad, and many more in the Nizam's territory, the immense tank east of Gooty, the vast network of tanks south of Trichinopoly, and the ruins and relics of great works of this description in the now-deserted jungles of Goomsoor, denote a system of irrigation superior to anything that we have effected. All the tanks, or artificial lakes, to which we now refer are of large dimensions, and confer those peculiar benefits on the country which we have hitherto neglected to provide, and even in some instances, where we found the works in existence, to maintain in good order. We have constructed some annicuts and a few canals, but for the

storage of water in the hot season—the special requirement of India—we have done next to nothing. I could myself point out more than a hundred tanks that are in ruins—tanks that must have originally irrigated many hundred acres of land, and would probably in the aggregate water at least a thousand villages. The ancient Mahommedan rulers left us noble examples of architecture, elegance of design, massiveness, and science in construction. The Taj at Agra, and its very inferior copy at Aurungabad, are good examples of masonry. There are also some fine examples of stonework and scientific construction in the Mahommedan remains built by Yoosuf Khan in 1489 around the very ancient Hindoo city of Vijzapúra. They were also aware of the importance of canals, and commenced our present system in the north. Thus the history of native engineering in India as regards the Hindoo is not brilliant, but it was useful. Yet we, with all our boasted science, have failed to do what the Hindoo did in a most efficient manner in many parts of the country (see a map of the Tondeman's country south of Tanjore, it is a network of tanks), that is, store water all over it We have taken water by annicut in the large deltas, following the example set us by the natives; but in storing water against an insufficient monsoon we have done scarcely anything, yet this is the great want of India to protect her from those dire famines, when the dead may be reckoned by tens of thousands. There is no country in the world that so much requires the storage of water; and under its native rulers, who were well aware of their obligations and interests on this head, no country was better provided with such hydraulic works as the science of those days and the limited means at their disposal enabled native princes and private benefactors to construct. As I have before observed, our grandest works of irrigation are only the amplification of Indian ideas. The Godavery annicut, for example, is a copy of the old Coleroon annicut. If the large rivers in India were all systematically attacked in the same manner as the Coleroon, their fertilising waters might be made to bring millions of acres into cultivation, instead of flowing idly to the sea. North of the Toongabuddra to the Ganges little has been done. The upper portion of the Godavery, the Wurda, the Poorna, the Taptee, the Nerbudda, the Mahanaddy, the Pyne Gunga, the Wyne Gunga, the Soane, and the Betwah—all these great rivers have scarcely been touched —(Extracts from "P. Works Reform in India." 1873.

OFFICAL ACCOUNT IN PROGRESS REPORT, 1873.

In the fourteen districts of Madras there are said to be 43,000 tanks, all of native origin, with probably 30,000 miles of embankments and 300,000 separate masonry works. The revenue dependent upon tanks was £1,500,000, yet up to 1853 not one new tank had been made in Madras by the English, though many had been allowed to fall into disrepair. The Viranum tank has an area of thirty-five square miles, and an embankment twelve miles long, still in full operation, after an existence of fabulous duration; it secures an annual revenue of £11,450. The Chembrumbaukum, in Chengalput, looks like a natural lake. The embankment is over three miles long, and the tank maintains rice-cultivation nearly ten thousand acres in extent. Its safety during floods is secured by six waste-weirs (*calingulas*), with a total of 676 feet of escape-channel. The enlargement of this fine tank was sanctioned at a cost of £41,000. (Up to 1872 half the work was finished. The English acquired the Krishna delta in 1766, and for eighty years they did nothing, while famines periodically desolated the land.)—(Extract from Progress Report, 1873, B.B., pp. 58, 60.)

OLD CANALS OF NORTHERN INDIA.

(By Lieut C. C Scott-Moncrieff, R E., author of the work on "Irrigation in India and Southern Europe.")

Probably no one has travelled abroad without being struck on his return with the rare green of our grass, and if he has thought over it, he will see that that rich verdure is one good result from our many rainy days. Imagine our average temperature raised twenty degrees, with a rainfall nearly the same as at present, compressed into three or four months instead of falling all the year round The evident consequence would be that not only our grass would soon be brown, but that our crops would entirely fail. This is nearly the condition of great portions of India. The bulk of the rain falls in one season (from June to September, in Northern India), and a few wet days, which cannot be relied on, are all that is to be had during the rest of the year. Seasons of total drought return with a sad frequency, when the rain fails altogether, and the earth, without a cloud to shelter it for months from the baking sun, becomes as hard as stone. Then we have a famine such as depopulated the North-West Provinces in 1837-38 and in 1860-61, and such as has still more awfully lately visited Orissa.

The most ordinary foresight would force even a half-savage nation to provide against the recurrence of so terrible a visitation, and so we find from the earliest times engineering works constructed to store water and enable it to be thown over the country. In Central and Southern India great dams were built across rivers and valleys, so as to make immense tanks and divert the water from its course; and where, as in parts of Northern India, the country did not admit of this, each field had its well, from which the precious liquid was raised by various rude contrivances.

The first irrigation canal we know anything of, in North India at least, was made about the year 1350 by the Emperor Feroze Toghlak, one of those enlightened and able monarchs who did so much for early India, bringing to bear on the hot plains which his fathers had overrun the energy and vigour of his northern habits and Turkoman descent. It is recorded of him that he built fifty dams across rivers to promote irrigation, forty mosques, thirty colleges, one hundred caravanserais, thirty reservoirs for irrigation, one hundred hospitals, one hundred public baths, one hundred and fifty bridges, besides many other edifices for pleasure or ornament. Feroze drew the canal which still occasionally goes by his name from the river Chetang, one of the drainage lines of the Sub-Himalayas, to water the parched districts of Hansi and Hissar, about a hundred miles west of his capital at Delhi. It is probable his successors allowed it to go out of repair, till it was restored and vastly improved about two hundred years later by the Emperor Akbar, one of the greatest and wisest rulers of that or any other age and country. His son Shah Jehan, the Louis XIV. of the East, carried on the work, till a system of canals was completed about four hundred and twenty miles long; the water not being drawn from the insignificant Chetang, but from the Jumna, whose sources are supplied by the endless Himalayan glaciers, and which consequently only comes down in greater volume the greater the heat which melts the ice.

An irrigation canal and a river are alike streams of water; one may be said to be diametrically the opposite of the other. A river, rising from almost nothing, increases as it goes on, choosing the lowest parts of the country it flows through, and carrying off the water by numerous branches to the right and left, which in their turn drain the fields on their banks. The irrigation canal, on the contrary, drawn from some great river,

speedily seeks the highest ridge of land, and decreases in size as it goes on feeding its branches, which in their turn distribute the water over the fields through which they run.—(Extract from *Good Words.*)

Canals made by the Emperors Feroz, Akbar, and Shah Jehan.—The Emperor Feroz Shah, between 1351 and 1388, drew a canal from the Jumna to water his favourite hunting-ground at Hissar. For a hundred years no water flowed to Hissar, when, in 1568, the Emperor Akbar issued a decree ordering the canal of Feroz to be restored It is singular that the "Ayan Akbara" makes no mention of this work of Akbar, and we are indebted to Colonel F. Yule for our knowledge of the original *sanad*, which places the fact beyond doubt.

In 1626 the Emperor Shah Jehan projected a branch from the canal of Feroz to convey water to the city of Delhi, and Ali Murdan Khan was his engineer. The Delhi canal crossed the low land by a masonry aqueduct, traversed the Aravah hills *by a channel cut through the solid rock sixty feet deep* at the crest, and flowed through the city in a masonry bed, throwing off innumerable minor streams. For one hundred and fifty years it continued to be efficient, but in 1753 the Delhi branch ceased to flow. Ali Murdan also made a canal in the Doab.—("Progress and Condition of India," B. B. 1873, p. 48.)

IMPORTANCE OF WELL-IRRIGATION.

(By Colonel Baird Smith, R.E)

They rank with the greatest rivers in the extent of their influence, and it is the larger and more universal, inasmuch as the supplies from them are accessible to almost every proprietary community however modest its resources, or however limited its possessions. Hence the immemorial importance of that branch of artificial irrigation which is dependent on wells. Because of the minuteness of its component elements, we are apt to undervalue its magnitude and importance, in contrast with those greater sources of supply furnished by our canals of irrigation. It is only in canal districts where great breadths of land can be thrown under irrigation that, as a general rule, a true surplus produce can be created, and the farmers can feel the full benefit of the high prices. The depths of wells range from twenty to eighty feet.

A permanent well is equal to the irrigation throughout the

year of nine acres, and a temporary well is equal to that of three acres. I have known many instances of from fifteen to twenty acres being brought to maturity under a single large and bountifully supplied well.—(Report on the Famine of 1860-61, P. R., pp. 80-84.)

WELLS IN THE NORTH-WEST PROVINCES.

(By Colonel Greathed, R.E., C.B 1873.

The depth at which water is found in the plains varies from ten feet to fifty feet below the surface. Deeper wells, lined with brushwood cylinders, and worked by bullock power, cost from £5 to £18 a piece, and employ six men and three pair of bullocks every day to keep five acres watered. The duration of such wells varies according to the soil, generally between two and ten years. As a rule, the springs can only be reached by wells lined with brickwork, costing from £15 to £30 a piece, which cost is almost prohibitory to their employment for irrigation. Where water is plentiful, deep wells pay best when made of sufficiently large diameter to allow of three or four pairs of bullocks to work at once, in which case they command twenty acres of land, and cost up to £80 and £100 a piece.

SUPERIORITY OF CANAL IRRIGATION.

Colonel Greathed describes the superior effects of canal irrigation in the North-Western Provinces as compared with that afforded by wells. "But, besides producing food for the support of human life, canal irrigation created sustenance for cattle, which was produceable by no other means, and, at a crisis when wells failed in well-irrigated districts, and herbage and fodder depended on abundant water, the cattle of the Doab were saved, strong to labour in the work of the following harvests, whilst elsewhere those harvests also were reduced by the want of cattle which had been swept off by the drought (in 1868-69).

COST OF RAISING WATER FROM WELLS.

The great objection to the well system is its cost (not so much in the original construction as in working it with the present ineffective mode of raising the water) The bullocks employed seldom last more than three years, and are worn out. The expense of well-irrigation is estimated at from forty to sixty rupees (£4 to £6) per acre per annum.

Few greater benefits could be conferred upon the country than the introduction of an improved machine for lifting water. Such a machine must be cheap, simple, capable of being easily repaired by a village artisan, and of raising with a pair of bullocks working on the level twice as much water as a pair working on an inclined plane can raise with the bucket. Several machines for lifting water have, we believe, been recently invented, and we think Government should ascertain if any of them answer these conditions, and should then take measures for their general introduction. We spend money enough upon inventions for the destruction of human life, and might well spare a little for inventions which tend to preserve it.—(*Times of India*, February, 1869.)

CESS ON WELLS.

Wherever in Gujarat wells have been found to exist at the time of the revised settlement, they have been carefully noted, the qualities of their water classed, and the fields in which they are found have an extra cess levied on them, over and above the dry-crop rates to which they would be liable, had the wells no existence at all. This has given rise to general dissatisfaction among the cultivating classes of Gujarat, from the fact that the wells were never the property of the State, in fact, the State never contributed a farthing towards their construction. The injustice of this levy is further heightened from the circumstance that new wells constructed after the introduction of the revised rates of settlements are exempted from all future assessment.

The plea that in levying rates on old wells the British Government has simply followed the practice of the native rulers, is founded upon a misconception of the essential characteristics of the Nurwa tenure. The British Government while openly professing to continue the Nurwa system, in the form in which it has hitherto been found to exist in the country, is clearly responsible for a departure from the original and essential principle of the settlement in levying, over and above the *Jeerayat* or dry-crop rates, a separate and extra cess on wells which are the private property of the ryots, and with constructing or repairing which the State has had nothing whatever to do. That this is an illiberal policy, unworthy of a wise, beneficent, and enlightened Government, who profess to afford every encouragement to the development of agri-

cultural industry, and thereby to promote the true national wealth of the country, is even admitted by Government, as is manifest from the policy adopted in exempting old wells in certain parts of the Dekkan. The question naturally arises, Why not exempt *all* old wells, thereby applying one universal rule to improvements effected in land? Owners of old wells have as equal a right to exemption as those of new wells, or, perhaps, greater, from the fact of their having laid out capital in improvements at a period when capital was very scarce in the country, and also, in some cases, under a full assurance of exemption from future rates.

It has been urged that owners of old wells have already reaped the fruits of their improvements in the exemption they enjoyed up to the period of the revised settlement But should this be held forth as a pretext for taxing them on the introduction of the revised settlement? Should it not, on the contrary, give them a *prescriptive* right to exemption hereafter? Having hitherto enjoyed freedom from any imposition on their wells, they are the more entitled to a *continuance* of that exemption than others. In not having exempted them from the levy of a cess which, at best, is precarious, Government has laid itself open to a charge of wrong doing, which it is bound in the true interests of right and justice, as well as of the happiness of the commonwealth, to redress

Supposing, for a moment (what really is not the case as shown above), that wrong was done by native rulers in making a charge on irrigated lands, it surely does not follow that the British Government should therefore perpetuate it, after being once conscious of the mistake.—(Notes on Kaira, Gujarat, by Javerilal Umiashunker, pp 33-34.)

A PROTEST BY A SETTLEMENT OFFICER.

We attempt to defend the false principle of taxing capital expended in sinking wells by the argument that, as the produce of garden land is greater, so the share thereof due to Government should be in the same proportion. I have never been able to understand the force of this argument, or to recognise the right which the State claims to a higher assessment on lands irrigated by wells constructed out of the hard-earned savings of the cultivators; and, with the liberal provisions of sections of the Survey Act, I see immense difficulty in convincing the ryots of the justness of our present

claim on their wells. Why, sir, have we such difficulty in making the incident of the well-assessment equitable—whether we put it on the bag, the well, or the soil? Simply, I submit, *because we cannot make right in practice what is wrong in principle* I foresee that if any great calamity should overwhelm this province—drought or famine, for example—our mode of taxing private capital expended in sinking would be condemned by all sound economists. Colonel Baird Smith was of opinion that to keep an agricultural population above want, under all vicissitudes, one-third at least of the cultivated land should be provided with the means of irrigation. Now, what is the present position of Neriad, in this respect the most highly irrigated talooka in the province? Of a cultivated area of 128,219 acres, 11,930 only, or a little over nine per cent. (Government and alienated exclusive), is irrigated—less than *one-tenth* of the whole available area. We draw [illegible] we can out of Gujarat, do not expend one shilling in works of irrigation, and tax wells besides. I cannot think this is the way to be forearmed for the evil hour, which may come when we least expect it.—(Major C. J Prescott to A. Rogers, Esq., Revenue Commissioner, January, 1867.)

BURKE'S SPEECH, HOUSE OF COMMONS.

The Carnatic is refreshed by few or no living brooks or running streams, and it has rain only at a season, but its product of rice exacts the use of water subject to perpetual command. This is the national bank of the Carnatic, on which it must have a perpetual credit, or it perishes irretrievably. For that reason, in the happier times of India, a number, almost incredible, of reservoirs, have been made in chosen places throughout the whole country; they are formed for the greater part of mounds of earth and stones, with sluices of solid masonry; the whole constructed with admirable skill and labour, and maintained at a mighty charge. In the territory contained in that map alone, I have been at the trouble of reckoning the reservoirs, and they amount to upwards of eleven hundred, from the extent of two or three acres to five miles in circuit. From these reservoirs currents are occasionally drawn over the fields, and these watercourses again call for a considerable expense to keep them properly scoured and duly levelled. Taking the district in that map as a measure, there cannot be in the

Carnatic and Tanjore fewer than ten thousand of these reservoirs of the larger and middling dimènsions. These are not the enterprises of your power. These are the monuments of real kings, who were the fathers of their people, testators to a posterity which they embraced as their own. These are the grand sepulchres built by ambition; but by the ambition of an insatiable benevolence, which, not contented with reigning in the dispensation of happiness during the contracted term of human life, had strained, with all the reachings and graspings of a vivacious mind, to extend the dominion of their bounty, beyond the limits of nature, and to perpetuate themselves through generations of generations, the guardians, the protectors, the nourishers of mankind.

SPEECH OF CHISHOLM ANSTEY, LATE M.P., ETC.

Take only one portion of the territory which we have traversed to-night—take the Carnatic. where are the 30,000—there were more, but take the smallest number—where are the 30,000 wells and tanks which covered the face of that region with smiling green fields ages ago? Why, they have disappeared in the course of the ravages of conquest. I do not say that the fault is entirely due to ourselves, for that would be to assert an untruth, but our neglect completed the ruin which the ravages of the conquerors who preceded us brought upon that district. You remember that every one of those wells was a public work—it was an endowment due to the piety and humanity of wealthy natives, and cost the country nothing. Where are all the other great works of navigation and irrigation—irrigation principally—which India had long ago when India was wealthy? It has been the misfortune of that land to be scourged by conquest, and by the administrations which conquest has brought in its train. We have done much for India, and we are not chargeable with all the misery which India has sustained at the hands of her conquerors; but of the conquerors we are the last, and we have had a certain share in the promotion of the evils the existence of which we deplore. I say we are bound to make reparation for wrong done, or for what is much the same thing, for disregard and neglect of our duty. We are bound to do all that in us lies at this moment to make that reparation in the most effectual way, namely, by enabling the natives of the soil to live upon the soil, instead of dying by thousands and hundreds of thousands upon it.

In China every acre of land was cultivated, the land being irrigated either by the rough-wheel of the country, or by the simple process of dispersing the water from the trench by means of the foot. The consequence was that in China the mountain, the desert, and the sea-shore were being taken into cultivation more and more even to this day. The Government of China had not had the great benefit of our civilisation and our example :—if it were a benefit, for he could not but regret that, before any Europeans took possession of India, there were no less than 30,000 wells and tanks in the Carnatic, the whole of which had been dried up, and the Carnatic, which was once a fertile district, had become nothing but a waste.—(Speech, East India Association.)

COST AND PROFIT FROM TANK-IRRIGATION.

(By Lieut.-Col. Greenway)

CHARACTER OF THE RAINS.

The year in India being unequally divided into wet and dry seasons, there is, during the first, too much water, and during the second and longest too little, for the agricultural requirements of the land. Therefore much of the most valuable land is, while left in the state of nature, so flooded during the rains as to be useless, and very much more is, during the dry season, an arid desert. The quantity that runs to waste is something enormous. One foot of rainfall on a square mile gives 1,032,532 cubic yards, or 174,239,775 gallons, and the rainfall during a monsoon may be averaged at thirty inches at least.

OBJECT OF IRRIGATION WORKS

Is to rectify this unequal distribution of water, to arrest that which would otherwise run to waste, distribute it to the lands where it is required, and store up in tanks as much as may be needed for use during the dry season.

In many parts of the country, and more particularly in the hilly districts, smaller rivers are found, often with rocky beds, which bring down in spasmodic freshets, five or six times during a monsoon, a mass of water equal to the requirements of several thousand acres.

COST OF CONSTRUCTION.

To give some idea of the cost of construction, two illustrations may be given. The first is of a tank constructed by closing a gorge between two rising grounds. The embankment was 1,200 yards long, average height 9 yards, top width 3 yards, inner slope $2\frac{1}{2}$ to 1, outer $1\frac{3}{4}$ to 1. It had a dry stone revetment 1,000 yards long, and carried up to two feet above full-tank level. The rest of the bund was turfed. It had two fine sluices and a calingala 150 yards in length. The fall of the land above the tank was 12 feet per mile; the greatest depth of water in the tank 30 feet, and its cubical contents 34,730,000 cubic yards of water. It received the drainage of ninety-seven square miles, and sufficed for the irrigation of 3,470 acres of rice cultivation, the gross value of the product of which was £8,154 10s., and net profit to the farmers average £4,337. The cost was about—

	£
243,000 cubic yards earthwork	2,025
7,000 cubic yards dry stone revetment	1,400
28,800 square yards turfing	90
Two very fine sluices	280
Calingala	1,000
Sundries	245
Total	£5,040

AVERAGE ANNUAL REPAIRS

Of such a tank (it being properly constructed) for a period of fifty years ought not to exceed £30 per annum; total, £1,500; making entire expenditure on the work, £6,540.

PROFITS FROM TANKS.

During the same period the net profits would be £216,850, or deducting ten per cent. for bad years, £195,165. In the second illustration of the Nellore tank, one end of the bund rests upon a rising ground, the other gradually ascends the natural slope of the plain, which is only four feet in the mile. The bund is 9,680 yards long, and mean section 50 square yards. It has four sluices, and three small calingalas; and, as its principal source of supply is by a channel taken off from a river, it is furnished with a head-sluice on the said channel to exclude further supply when the tank is full. Its water, spread at fullest, covers six square miles, and it contains 50,000,000 of cubic yards of water, or 8,437,500,000 gallons. As, however,

it receives, thanks to the river supply, an almost continual influx during four months of the season, it irrigates nearly 8,000 acres, and could irrigate much more. If a precisely similar work were to be constructed now, it may be estimated as follows :—

	£
484,000 cubic yards earthwork	4,033
14,080 cubic yards rough stone	2,816
Three calingalas, about	300
Four sluices	400
Head sluice	500
Turfing	726
Sundries	444
Total	£9,220

Net profit on 8,000 acres, say £10,000 per annum.

Large tanks are much more profitable than small ones, the ratio of embankment to cubic content of water being less. The proportionate waste by evaporation and absorption is also less.

WET FARMING.

Wet farming is the term applied to the cultivation of such crops as require a continual supply of water, and which are usually supplied therewith (at least in part) by artificial means. The demand upon the artificial sources of irrigation varies greatly, both with regard to the sort of crop, the nature of the soil, and the normal character of the rainy season in the locality. In the Nunjenaad district of Travancore, extending between the mountains and the sea, from Colachel to Cape Comorin, the average rainfall does not exceed sixty inches, but is distributed over a longer season, as that part of the country partakes of both monsoons. The storage of water in tanks is necessary here, but only in moderate quantity. In calculating the requisite provision, an average of one cubic yard of water per hour per acre will, in the Nunjenaad, be amply sufficient, even in bad seasons, and including evaporation. And this, for the long crop of five months, would be met by the storage of 3,600 cubic yards, or 607,500 gallons for each acre to be cultivated. On the eastern coast the rainfall is less, and the requirements for artificial irrigation may be averaged at 2½ cubic yards per hour per acre; sandy fields sometimes taking as much as three. 10,000 cubic yards, or 1,687,500 gallons per acre for the season of five months, will, however, be an ample supply for rice under any circumstances, except perhaps in very deep sand, and will

include provision for loss by absorption and evaporation. One and a half cubic yards per hour will suffice for sugar-cane, but the provision must be continued for ten months. The time to plant is as soon as a supply of water is available; thus, in the Godavery delta, in the beginning of June or end of May. The crop takes eleven months to come to perfection.

DRY FARMING.

It includes all dry grains, as wheat, barley, jowarree, maize, millet, ragi, and the like; all vetches, dhall, grain, peas, &c., and also indigo and cotton, oil seeds, linseed, gingely—all crops which benefit by partial or occasional irrigation, but do not require so large or continuous a supply of water as is indispensable to the crops classed as wet—are included in dry farming. In this sense tobacco, chillies, turmeric, garden cultivation in general, will come under this head. If these crops are raised under channel irrigation, the requirement of water may be estimated at two-fifths that for rice; or if, as usual, under tanks, at one-half. The small difference is due to the greater proportional evaporation from the surface of the tank during the prolonged period for which its surfaces are required.

VALUE OF PRODUCE, EIGHT ACRES.

Dry grains, &c., are frequently raised upon the alluvial tracts of deltas as a second crop during the dry season, after a first crop of rice has been reaped; and if the land is good and the supply of water sufficient, the profits are very large. A pooty of land (eight acres) in the Tanaku talook, Godavery district, gave results as follows:—

First crop.—Transplanted rice sown in June and reaped in the end of December:—

	£	s.	d.
Value of crop, including straw . . .	18	0	0
Deduct cost of cultivation	4	0	0
	£14	0	0

Second crop.—Chunna or Bengal gram sown in January:—

	£	s.	d.
Value of crop	15	0	0
Deduct cost of cultivation	3	10	0
	£11	10	0

	£	s	d.
Total net value of crops	25	10	0
Deduct rent and water-rate	5	0	0
Net profit . .	£20	10	0

This was, of course, on good land, thoroughly well watered and drained.

RENT OF WET AND DRY LANDS.

Eighteenpence to eighteen shillings an acre, according to quality and site, the latter being for the best land, under reliable irrigation and inclusive of water-rate. This class of land is suited for the cultivation of rice, sugar, chillies, turmeric, &c. These are called wet crops. They can only be grown on irrigated land, the average rent of which, including cost of water, is thirteen or fourteen shillings the acre. On the higher plains cultivation is carried on of oil-seeds, hemp, vetches, maize, millet, and similar grains, cotton and indigo. The latter are much improved by a little irrigation, but do not require much. The rent of this land varies a good deal, but seldom exceeds five shillings an acre.

VALUE OF LAND VARIES ACCORDING TO FACILITIES OF TRANSPORT.

The value of land depends very greatly on the method of transport to and from the market, and so far the fact is sufficiently self-evident to make it seem absurd to notice it; but the ratio in which value varies with facilities of access in India is not a matter so generally known. The gradation of cheapness in means of transport is in the order aforesaid. On the Godavery canals the freight for stone, &c., exclusive of demurrage, was three-eighths of a penny per ton per mile. For grain and other farm produce, inclusive of demurrage, three farthings per ton per mile, the native farmers and dealers usually detaining the boats two or three days at each terminus. This was with native boats of small tonnage. Properly constructed boats, however, of three times the tonnage, could be worked by the same amount of labour, and the actual cost of transport would not exceed one-eighth of a penny per ton per mile. In the same district the difference in the price of produce grown on the banks of a canal and of produce grown ten miles from it, and requiring to be carried that distance by coolies, was as fifteen to

thirteen, giving an advantage to the farmer on the bank of upwards of fifteen per cent.—(Extracts from "Farming in India," by Lieut.-Col. Greenway.)

RENT OF LAND IN NORTHERN INDIA.

The water-rate per acre is about 5*s*. 6*d*. The average rent of unwatered land is about 6*s*. per acre, and of watered land 23*s*. to 24*s*., so that the water-rate is twenty-three or twenty-four per cent. of the land-rent.

IRRIGATED CROPS, N.W. PROVINCES.

For the wheat crop, which is grown in the cold season, and therefore at a considerably lower temperature than in Spain, four waterings are quite enough, and almost no other crop requires more, except rice and sugar-cane, which are sometimes irrigated as often as twelve times, and are watered by a rainy season as well.

IRRIGATION AND AGRICULTURE IN INDIA.

(By W. G. McIvor, F.R.C S., Superintendent, Government Chinchona-plantations, Neilgherry Hills.)

OUR CULPABLE NEGLECT.

We have done something towards raising the intellectual standard of the natives; at all events, we have done enough to count for something. But we have not done enough to count for anything in securing the material welfare of the people. We have been satisfied with giving them peace, security to life and property, and justice—the great wants under the rule of our predecessors. All larger measures for the public welfare, for the prosperity and progress of the people, have been delayed, neglected, or ignored. Our inactivity—culpable in this respect—has produced the most disastrous results. Famine and its concomitant evils—ruin, death, and the utter destruction of whole communities, still periodically visit us, to our shame and disgrace, in a land which ought to flow with milk and honey. Hitherto nothing has been done to store the superabundant waters of our mountain ranges. Thus for all past time these fertilising streams, so placed in the fittest localities for making all India blossom with abundance, have been allowed to

hurry back to the sea, a devastating flood, carrying death and destruction along the river banks, and even into the sea itself, where the fish die in myriads from the excessive influx of fresh water. When we observe the heavy deluges that in many parts of India annually spread wreck and destruction for miles on both sides of the river-banks, it is for us to devise how this potent element (although at present allowed to destroy) may be applied to our advantage.

SUN AND WATER.

It is obvious that in India all improvements with the object of developing the resources of the country must begin by storing water. Vegetation exists on water and sun. As the Irishman said, "with the sun in one hand and a watering-pot in the other," we can produce everything; without their conjoined influences we can produce nothing. Continuous rain is as injurious to vegetation as continuous drought. In the former case the plants are charged with nourishment, but the power of digestion is suspended. In the latter case, the power of digestion is active in the extreme, but nourishment is wanting. It is thus that showers and sunshine create great luxuriance in vegetation. Artificial irrigation produces still greater, for with artificial irrigation the sun continually stimulates and maintains the digestive powers, while the water supplied conveys the necessary nourishment.

QUANTITY OF WATER REQUIRED FOR CROPS.

Ten years ago the cost of raising water from wells averaged in the Madras Presidency two shillings for 500 cubic yards. In nearly all parts of India the price has now risen to four shillings. On ordinary soils water at this charge gives to the cultivator a profit of over twenty-five per cent. when used for the growth of wet crops. When used to bring dry crops to perfection, the quantity of water required, in addition to the rains, may not exceed from 700 to 1,200 cubic yards per acre. Applied in this way the return from water is much more than when used for the growth of wet crops, where the quantity needed is great; rice, sugar-cane, &c., requiring (according to the season) from 8,000 to 16,000 cubic yards of water per acre to bring them to maturity, because during the dry season of the year the evaporation is very great.

STORING OF WATER.

The formation of annicuts, and of weirs across rivers, do not meet the requirements of this country. These are useful to divert the water of rivers during the rainy months over the neighbouring plains, and can at best only secure to us a small portion of the produce the country is capable of yielding. In most parts of India the rain falls in sudden and heavy torrents, runs rapidly off the water-sheds, and, accumulating in the channels, causes inundations. We thus suffer from two evils—now drought, then inundation. What is wanted to avoid both of these two evils is to store the water of the rainy months, and not allow it to return to the sea a destroying flood, carrying away our crops, annicuts, bridges, and other works of utility. When thus stored the water should be allowed to escape in such quantity only as is necessary. In the valleys of the plains, but more especially in our mountain ranges, lakes should be constructed with capacity sufficient to store at least a half more than the average rainfall of wet years. The flow from these lakes should be regulated into the rivers or water-channels, so as to maintain uniformly in them sufficient water for the purposes of navigation or irrigation, and this quantity should not be allowed to increase or decrease throughout the year. Under these conditions every acre of land in India might at all seasons be covered with luxuriant crops, because our summer is favourable for producing one sort of crop, our winter still more favourable for another.

CORRECT APPLICATION OF WATER.

Next in importance to storing water, is to apply it in such a manner as to produce the greatest results with the smallest possible quantity. We cannot here enter into details. We shall, therefore, merely notice some of the main principles which should govern the practice of the cultivator.

In applying artificial irrigation the first object is to secure the greatest quantity of produce from the land. The second, to secure the health of the inhabitants. At once to obtain both these important results it is necessary to maintain the water *continually in rapid circulation.* In low localities this may be difficult, but it must always be kept in view both by the cultivator and sanatarian. A judicious arrangement of the

drainage will generally effect all that is necessary, especially when the supply of water is abundant. When water is allowed to stand upon the surface of land for an indefinite time the land becomes "water-logged," and the gaseous emanations from it are highly injurious to health. While land in this condition is *sour*, and incapable of supporting healthy vegetation, even aquatic plants become unhealthy on such lands. Apart from this souring effect on the land, stagnant water draws up saline matter, which deposits upon the surface, and seriously injures or destroys vegetation. It is thus evident that a correct application of water is of paramount importance, otherwise, by a misuse of this great fertilising agent, we may create both sterility and sickness. This, unfortunately, has already been done where the appearance of "reh" (saline substance) has produced alarming results. The only safeguard against this is to secure efficient drainage. It is, of course, understood that all lands under wet cultivation are dried during the process of tillage, and in this state exposed to the action of the sun for a longer or shorter period, as this exposure is necessary to maintain fertility.

SUGAR-CANE AND IRRIGATION.

The system that prevails of flooding lands is injurious to all plants except aquatics. Water is well applied in flooding a paddy-field, because rice is an aquatic; but it is wrongly applied by flooding a field of sugar-cane, cotton, or any other plant which is not aquatic, because flooding the land in which such plants grow excludes the action of the atmospheric air, causing the roots of the plants to rot or become unhealthy, while the water, having stood on the ground, solidifies it, and when drained off causes a hard crust to form on the surface, which almost entirely excludes the action of the air on the soil, thus destroying the very object for which cultivation is undertaken, namely, to loosen the soil, so that it may hold the moisture in suspension between its cavities in combination with atmospheric air. It is this latter condition of the soil that gives the greatest luxuriance to all non-aquatic plants; and to maintain this condition, under every circumstance, should be the aim and object of the cultivator. The irrigation of all plants which are not strictly aquatic should be effected by the water being conducted in channels between the rows; the moisture being allowed to reach the roots by percolation. A very effective system of

applying water in irrigation is to carry it in earthen pipes at eighteen inches, more or less, under the surface of the land, the depth being regulated according to the crops. The distance between the rows of pipes being about five feet. For garden purposes this system can be applied with very great advantage.

COST OF TRANSPORT.

It becomes an object next in importance to the fertilising of our fields, to devise an effectual means of reducing the cost of land-carriage and agricultural operations in this country. The descent of our rivers, from our elevated mountain tracts to the plains, offers a power which may be made available to transport, at a very trifling cost, the whole of the produce of this country. All that is required to enable us to do this is to devise the means of storing, preserving, transporting, and applying, when and how we please, what portions of this power we may require.

CONCLUSION.

The true strength of every government is a place in the heart and good-will of their subjects. This is the strongest position attainable by any government, and compared with it every other is more or less degrading. Trusting in our power, we are prone to overlook and pass unimproved the many opportunities of procuring for ourselves the respect and good-will of the people. We occasionally turn a deaf ear to all appeals to reason. This is incompatible with the material prosperity of the people. It is one which it behoves us to make every exertion to remove. To do which we must lay aside our prejudices; we must guard with the utmost jealousy and suspicion our own actions; we must govern on wise and just principles, rejecting with disdain all selfish motives. If we continue to entrust the welfare of India to fortune, and to the do-nothing policy, we must reap the harvest of disappointment and disaster. Let us try discretion in action. Let us call forth resource in remedies, and ingenuity in applying them. The sooner the better.—("Our Mountain Ranges; How India may be Converted into the Grain Store of the World," by William Graham McIvor, Superintendent, Government Chinchona Plantations, Neilgherry Hills, Madras, 1867. Extracts.)

DIFFERENCE IN YIELD OF PRODUCE FROM LAND IRRIGATED AND UNIRRIGATED.

(By Col Greenway.)

YIELD OF RICE CROP.

The average yield of rice cultivation, first crop, was found to be as follows, as per result of a great number of experiments conducted in different parts of Southern India: the rate is in pounds of paddy per acre.—

	lbs
Best white rice, fully irrigated	2,400
Maximum shown by the experiments . . .	3,650
Red rice, fully irrigated, averaged . . .	1,800
Black rice, partially watered, averaged . .	1,200
Black rice, dependent on rain only, averaged .	700

COST OF CULTIVATION AND PROFITS.

A few examples from actual practice will illustrate the cost of cultivation and net profit from an acre of white rice under perfect tank irrigation, in the Shencota talook, Travancore:—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land tax, including water (very high) .	0	18	0	3,360 lbs. paddy, sold for	3	7	2
Cost of cultivation (cheap) . . .	0	9	0				
Total .	£1	7	0				

Net profit . . . £2 0*s*. 2*d*.

In this case the straw was not valued, there being no demand for it. It was burned on the land for manure, thus reducing cost of cultivation.

An acre of irrigated rice in the Tynakoo talook, Godavery district, showed as follows:—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land-tax and water-rate	0	12	0	2,450 lbs. paddy, sold for	3	1	3
Cost of cultivation .	0	10	0	Straw . . .	0	6	0
Share of plant . .	0	2	0	Total .	£3	7	3
Total .	£1	4	0				

Net profit . . . £2 3*s*. 3*d*.

An acre of red rice, under pretty good, but not perfect, tank irrigation, in the Nellore district, the soil being the ordinary black earth called "black cotton soil," showed as follows:—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land-tax, including water	0	10	0	1,600 lbs. paddy, sold for	2	0	0
Cost of cultivation, &c. .	0	12	0	Straw	0	7	0
Total .	£1	2	0	Total .	£2	7	0

Net profit . . . . £1 5s 0d.

A CONTRAST: RETURNS FROM UNIRRIGATED LANDS.

As a contrast the results of an acre of black rice dependent solely on the rain in an unirrigated portion of the Masulipatam district—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land-tax . . .	0	12	0	960 lbs. paddy, sold for .	1	4	0
Cost of cultivation .	0	8	0	Straw	0	5	0
Total .	£1	0	0	Total .	£1	9	0

Net profit . . . . £0 9s. 0d.

The land tax however was, in this instance, exorbitantly high, and has since been reduced.

An acre of rice without irrigation in Orissa showed—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land-tax . . .	0	5	0	650 lbs. paddy, at average value . . .	1	0	0
Cost of cultivation .	0	8	0	Straw	0	7	0
Total .	£0	13	0	Total .	£1	7	0

Net profit . . . . £0 14s. 0d.

The average rain-fall per annum during a period of six years in the Godavery district was 35·2 inches. The maximum was 46·4 inches, and the minimum 19·9. This will serve to illustrate the extraordinary variableness of the monsoons, and the necessity for proportioning our storage of water to the possible requirements of the worst year.

SUGAR-CANE: QUANTITY AND VALUE.

Sugar-cane is a most valuable crop, but requires greater care and more capital than rice. It is grown on the western

coast, and in the irrigated deltas on the eastern side of India, with great success. In these deltas the rich alluvial soil suits the plant admirably. Black earth, where nodulous limestone is found, or a deep, warm, brown earth, composed of clay and sand, mixed likewise, answers very well.

An acre of sugar-cane on good soil, and well watered, has been found to yield with careful cultivation about 2,000 lbs. 400 gallons of juice give, on an average, 60 gallons of sugar and molasses.

One acre of Dodeputla in the Godavery delta, under native cultivation, gave the following results:—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land-tax and water-rate (low)	0	10	0	1,600 lbs., at market rate	13	6	8
Ploughing (native fashion)	0	4	0				
Value of plant	0	11	0				
Manuring, &c.	1	4	0				
Clearing, weeding, &c.	2	0	0				
Cutting crop, &c.	1	2	0				
Total	£5	11	0				

An acre of sugar-cane in Orissa under native cultivation showed as follows:—

Expenses.	£	s.	d.	Return.	£	s.	d.
Land-tax (high)	1	5	0	28 maunds and 5 seers	12	10	0
Ploughing	0	3	9				
Value of plant	0	10	0				
Manuring, &c.	1	11	0				
Water	0	16	0				
Cleaning and cutting crop	2	16	0				
Total	£7	1	9				

Interest on prime cost of machinery is not included in the above expenses. The charge for water, in the second example, includes the cost of baling in the dry season, which, in the former one, was not required, the land being under channel irrigation, with a constant supply at a high level. An inferior sugar is made in India from the sap of the Palmyra palm. The sap is collected as for toddy, by cutting the branches at the head of the tree, and suspending earthen pots below the

cut; these are removed in the early morning. The processes of boiling, &c., much the same as for cane sugar.

YIELD OF DRY CROPS.

The average yield per acre of some of the commonest dry crops was found to be as follows :—

Black rice, dependent on rain alone	700 lbs.
Bengal gram, or chunna	450 ,,
Madras gram, or coolty	600 ,,
Dhall	500 ,,
Cotton (kuppas), unirrigated	200 ,,
Indigo, unirrigated, of dry indigo	30 to 50 ,,
Wheat, partially watered (bushels)	25 to 30 ,,

The annual value of an acre of red chillies, during a period of five years in the Godavery district, was found to average £8, cost of cultivation being about £2 3*s.*; but for this partial irrigation was always requisite.

CONCLUSION.

The soil for the most part is of exuberant fertility *if watered*, and an ample supply of water can be commanded if rational precautions be taken to secure it. The supply of labour at reasonable rates is also abundant, and the country affords ample room for the enterprising, and will continue to do so for many years to come. The improvement of the Indian revenue has proved that the resources of the country are far indeed from being developed; and it is no longer regarded as a dream of enthusiasm to anticipate that (supposing the blessing of peace continue to be vouchsafed), the revenues of India may be doubled in the next twenty years, and the wealth of its people multiplied tenfold in the same period.—(Lieut.-Col. Greenway, "Farming in India." Extracts.)

YIELD OF WHEAT IN N.W. PROVINCES AND PUNJAB.

The extension of irrigation in Upper India is almost annually raising the outturn from the soil. In the canal districts of the North-Western Provinces the yield of wheat is returned at from 1,500 to 1,600 lbs. per acre on irrigated and 1,080 lbs. on unirrigated land. This is not so far short of the average rate in England in the sixteen years ending 1867, when it was 1,670 lbs., falling to 850 lbs. on unmanured, and rising to 2,130 lbs. on manured land. The canal districts of the Punjab

are only a little behind those of the North-Western Provinces. Loodhiana and Jullundhur yielded above 1,200 lbs. the acre last year, and Umballa and Goojranwala above 1,000. Out of 18 millions of acres under cultivation in the Punjab in 1871, no fewer than $5\frac{1}{2}$ millions were under wheat in the spring harvest.—(*Friend of India.*)

CROPS IRRIGATED BY THE GANGES CANAL.

	Per cent
Rubbee crop:—	
Wheat	38 78
Barley	22 47
Gram	3 71
Miscellaneous . .	3·12
	68·08
Khuriff crop:—	
Indigo	7 00
Cotton	4·10
Rice	4·02
Indian corn . . .	2·89
Miscellaneous . .	8·28
	26·29
Sugar-cane . . .	5·63
Total per cent. .	100·00

Villages taking water during rubbee 5,797
" " khuriff 4,634

The percentage varies more or less in each year.

AVERAGE WEIGHT PER BUSHEL OF CLEANED GRAIN, PUNJAB.

Grain	seers. ch	lbs
Wheat . . .	30 1	=61 8
Barley . . .	15 4	=31·3
Mukhu . . .	19 2	=39·3
Bagha . . .	19 5	=39·7
Jowaree . . .	16 11	=34 2
Oord . . .	27 6	=56·3
Dhall (mong.) .	27 4	=56 0
Gram, unparched .	17 4	=36·5

—(Statistical Reporter.)

VALUE OF CROPS IRRIGATED BY THE GANGES CANAL

			Rs.
Sugar-cane .	112.690 acres	at 78 Rs. .	87,89,820
Wheat . .	461,534 "	37 " .	170,66,758
Barley . .	134,192 "	16 " .	21,47,070
Pulse . .	32,455 "	24 " .	7,78,920
Jowar . .	5,485 "	15 " .	82,260
	746,356 acres		Rs. 288,63,830

—(Mr. Halsey's Estimate, *Economist*, June, 1872.)

CHARGES FOR WATER PER ACRE, GANGES CANAL.

Crops.	Lift. Rs a. p.	Flush. Rs. a. p
Sugar-cane	3 9 7	5 0 0
Garden produce, &c. . .	2 0 0	3 0 0
Indigo and rubbee . .	1 8 0	2 4 0
Khureeff	1 0 0	1 10 8

On the Ganges Canal, sugar-cane and wheat are invariably irrigated, and, on the average, cane is watered eight, and wheat three times. The canal rates are for the seasons, not per individual watering.

IMPROVEMENT OF FOOD GRAINS IN RELATION TO CANAL REVENUE.

(Resolution, Government of India, November, 1868.)

It may be interesting to state that the statistical returns of the United States show that the acreage under Indian corn there in 1864 was decidedly more than that under wheat, being 17½ million acres against 13 millions,* and that the value of the produce was considerably in favour of the Indian corn, being 30 dollars an acre against 23 dollars for the wheat. In Wallachia and Moldavia, also, the area of maize cultivation largely exceeds that of wheat. There can be little doubt that there is great scope for the extension of the cultivation of this grain in Northern India in the Khureef fussul. Possibly there would be a difficulty in first introducing the use of it as a general article of food, but its wholesomeness is undisputed, and if it could be got to supersede the poorer khureef cereals, when irrigation is made available, the advantage would be very great.

The discussions which have lately taken place as to the prospects of utilising the monsoon waters of our larger rivers with financial advantage turn a good deal on the question whether the khurreef crops can pay a fair water-rate, and whether there is a prospect of an extension of the khurreef area if water is provided. The improvement of the staples thus becomes of much importance in relation to the profitable extension of irrigation, whether regard is had to the interest of the State or of the community generally. The time is certainly come when increased attention is required to these subjects.

It is worthy of notice that nearly one-half of the irrigated area is cultivated with maize, a crop which does not form an important item in the produce of the Western Jumna or Baree Doab Canal, though it could without doubt be readily raised.—(Resolution, Government of India, November, 1868.)

* In 1872, in the United States, maize, acres, 37 millions; wheat, 19 million acres.

NUTRITIVE VALUE OF INDIAN CEREALS.

(By Dr. Forbes Watson, Reporter, India products, London.)

ANALYSIS	WHEAT	BAJREE.	JOWAREE	RICE.	RAGGEE
	Per cent.	Per cent	Per cent.	Per cent	Per cent
Nitrogenous matter :					
Gluten, albumen . .	13·42	10 27	9·38	7·40	6·53
Woody fibre . . .	2 69	1 49	2 23	·39	3 36
Carbonous matter :					
Starch, gum, &c. . .	68·81	71·01	72 68	78 97	74·42
Fat or oil	1·15	3 27	2 04	·57	1·17
Oxide of iron . . .	·019	·026	018	008	004
Potassa	·014	·405	·207	·066	·534
Soda	·392	·132	·135	·082	·019
Lime	068	·064	094	·026	·617
Magnesia	·241	·239	·261	·103	·163
Chlorine	·059	·058	·016	·016	·048
Phosphoric acid . .	·817	·678	·856	·287	·595
Sulphuric acid . . .	·154	·105	·108	·080	·110
Silica	·029	375	·088	·099	·334
Moisture	12·00	12·00	12·00		12 00

The order according to which these cereals are arranged is determined by the amount of nitrogenous matter they contain.

Wheat stands pre-eminent, followed by bajree, and not jowaree, whilst rice and raggee occupy the lowest position. All the analyses have been reduced to a common moisture of twelve per cent, which is that to which all grains more or less approach.—(Elliott's "Mysore," 1871, p. 340.)

FODDER CROPS IN INDIA.

(By the Superintendent, Government Farm Estate, Madras.)

My experience has satisfied me that the Indian farmer is most bountifully supplied with these crops; indeed in this respect he is much better off than our English farmers. The Indian farmer has a great diversity of fodder crops at his command; he has crops that will grow in the hot weather and in the cold weather; on clay and on sandy soils; under wet or under dry cultivation. In this country a couple of months will suffice to produce a crop that in England could only be produced in double the time. Besides, many of these Indian forage crops are very rich in saccharine matter.

Amongst the crops which we have experimented with, as fodder-producers, are yellow cholum (*Holcus sorghum*), Chinese

sugar-cane (*Sorghum saccharatum*), cumboo (*Penicillaria spicata*), horse gram (*Dolicus uniflorus*), and common paddy.

Summary of the general results, giving the weight per acre of green fodder, in pounds, and the average number of days required to produce a crop :—

Fodder crops.	lbs.	days
Yellow cholum (dry)	10,000	90
Yellow cholum (wet)	12,000	60
Chinese sugar-cane (dry) . .	20,000	80
Cumboo (dry)	15,000	75
Horse gram (dry)	7,000	70
Paddy (wet)	8,000	65

Let these results be compared with the results which attended our attempted cultivation of English forage crops, such as clover, lucerne, rye-grass, rape, &c., or of English root crops, mangold wurtzel, khol rabi, &c. If half the time and money which has been wasted in the attempt to introduce these crops had been devoted to the improvement of indigenous or tropical forage crops, the Indian stock breeder or feeder would have been in very different circumstances to those in which we now find him.

IRRIGATION INCREASES THREE TIMES THE PRODUCE.

(By the Superintendent, Government Farm Estate, Madras.)

YELLOW CHOLUM (*Sorgham vulgare*).

Irrigation produces at least three times the weight of fodder obtained under dry cultivation. In the former case, the crop will continue to grow eleven or twelve months, and give six or eight cuttings; while in the latter only seven or eight months, and yield three or four cuttings.

DRY CULTIVATION.

Cost per Acre.

	Rs.	a.
Ploughing	1	0
Cultivating	0	6
Collecting weeds . .	0	12
Six tons of manure . .	6	0
Spreading manure .	0	3
Ploughing	0	12
Harrowing	0	2
Seeds	1	0
Sowing	0	12
Chain-harrowing . .	0	2
Carried forward	11	1

IRRIGATED

Cost per Acre.

	Rs.	a.
Ploughing . .	1	0
Cultivating . . .	0	6
Collecting weeds . .	0	12
Ridging soil . . .	0	8
Six tons of manure . .	6	0
Spreading manure . .	0	3
Splitting ridges .	0	8
Seeds	1	0
Sowing . . .	0	9
Carried forward .	10	14

	Rs.	a.
Brought forward	11	1
After Cultivation.		
5 Hand-hoeings	5	0
8 Bullock-hoeings	2	0
4 Cuttings	2	0
	20	1

Gross yield per acre from dry cultivation, 8 tons
Cost of fodder, 2 Rs. 14 a. 1 p.

	Rs.	a
Brought forward	10	14
After Culture.		
8 Hand-hoeings	8	0
12 Bullock-hoeings	6	0
6 Cuttings	3	0
Raising 500,000 gallons of water a height of 18 feet, and distributing the water, &c	20	0
	47	14

Gross yield per acre from wet cultivation, 24 tons.
Cost of fodder, 1 R. 15 a. 11 p

Weight for weight it contains a larger proportion of nutritious matters than turnips. It is best cut for fodder when two-thirds grown, and cut in the green state, it is readily eaten by horses, cattle, sheep, and pigs.

Cumboo (*Penicillaria spicata*).—We found the cumboo crop very valuable; it afforded us an abundant supply of green fodder at a time when, in this neighbourhood, it is usually very scarce. We can always manage to have something green for the stock between the months of October and May; but the great difficulty has hitherto been to find some crop that will yield green fodder during the months of June, July, and August. Of course, under irrigation, it is possible to grow yellow cholum so as to afford a supply of green fodder throughout the hot season.—(Extracts from the Annual Report for the year ending March, 1871, of the Superintendent Government Farm Estate, Madras.)

TABLE FOR CONVERTING AVOIRDUPOIS WEIGHTS INTO INDIAN WEIGHTS.

Tons.	Mans or Bazar Maunds			Cwts	Mans or Bazar Maunds.			lbs	Mans or Bazar Maunds		
	Mds	Srs.	Ch.		Mds	Srs	Ch.		Mds	Srs	Ch.
100	2,722	10	10	19	25	34	$7\frac{3}{8}$	100	1	8	$9\frac{3}{4}$
90	2,450	1	9	18	24	20	$0\frac{1}{4}$	90	1	3	$12\frac{1}{4}$
80	2,177	32	8	17	23	5	$9\frac{1}{8}$	80	0	38	$14\frac{1}{4}$
70	1,905	23	7	16	21	31	2	70	0	34	0
60	1,633	14	6	15	20	16	$10\frac{7}{8}$	60	0	29	$2\frac{1}{2}$
50	1,361	5	5	14	19	2	$3\frac{1}{4}$	50	0	24	$4\frac{3}{4}$
40	1,088	36	4	13	17	27	$12\frac{5}{8}$	40	0	19	7

Table for converting Avoirdupois Weights into Indian Weights (continued)—

Tons.	Mans or Bazar Maunds.	Cwts.	Mans or Bazar Maunds.	lbs.	Mans or Bazar Maunds.
	Mds. Srs. Ch.		Mds. Srs. Ch.		Mds. Srs. Ch.
30	816 27 3	12	16 13 $5\frac{1}{2}$	30	0 14 $9\frac{1}{4}$
20	544 18 2	11	14 38 $14\frac{3}{8}$	20	0 9 $11\frac{1}{2}$
10	272 9 1	10	13 24 $7\frac{1}{4}$	10	0 4 $13\frac{3}{4}$
9	245 0 $2\frac{1}{2}$	9	12 10 $0\frac{1}{8}$	9	0 4 6
8	217 31 4	8	10 35 9	8	0 3 $14\frac{1}{4}$
7	190 22 $5\frac{1}{2}$	7	9 21 $1\frac{7}{8}$	7	0 3 $6\frac{1}{2}$
6	163 13 7	6	8 6 $10\frac{3}{4}$	6	0 2 $14\frac{1}{2}$
5	136 4 $8\frac{1}{2}$	5	6 32 $3\frac{5}{8}$	5	0 2 7
4	108 35 10	4	5 17 $12\frac{1}{2}$	4	0 1 $15\frac{1}{4}$
3	81 26 $11\frac{1}{2}$	3	4 3 $5\frac{3}{8}$	3	0 1 $7\frac{1}{4}$
2	54 17 13	2	2 28 $14\frac{1}{4}$	2	0 0 $15\frac{1}{2}$
1	27 8 $14\frac{1}{2}$	1	1 14 $7\frac{1}{8}$	1	0 0 $7\frac{3}{4}$

REPORT BY MR. LYALL, SUPERINTENDENT, EXPERIMENTAL FARM, BERAR,

Whatever may be the result of our farming experiments, a system of irrigation and water-storage will be of inestimable service to the country; wherefore more is anticipated from the Irrigation Officer than from attempts to demonstrate the effects of superior tillage. Rivers and wells run dry toward the end of the hot season, in large tracts, and the use of the impure water to which the poorest classes are then condemned brings on epidemics. It would be possible, without straining facts, to show that no marked and wide-spread improvement in agricultural production can be anticipated while the water-supply in Berar falls to the dregs every year. We can plough an acre of land for Rupees 4-8-0 (*9s.*); while ploughing with the native plough is calculated to cost Rupees 6-15-0 (13*s.* 10½*d.*) per acre.—(Berar Administration Report, 1871.)

CAUSES OF LOW PRODUCTION OF AGRICULTURAL PRODUCE.

WANT OF MANURE AND WATER.

(Evidence of Mr. Ashburner, C.S.I., Revenue Collector, before the Select Committee, in 1872.)

I have no doubt that the present production does not amount to a fourth of what the land ought to produce. The want of proper manure for the soil is one thing, and ignorance of the proper methods of cultivation is another.

Measures have been carried out to utilise the cow manure in the small towns, to a certain extent in Ahmedabad, for instance, and in Kandeish; in the towns there it is sold; the sweepings of the town are sold, not probably the house manure, but the town sweepings; very little has been done to utilise the night-soil. I do not think that any prejudice exists against its use; the filth from the gaols, for instance, is taken outside the towns and buried, and after remaining for a year is used by the natives without the least objection. It is made into a compost for manure. I do not think that there is any objection to it.

POVERTY OF THE RYOTS.

Their difficulty is in their poverty; their want of capital, rather. If capital were applied more freely to the land, that would remedy practically the difficulties that exist. I have no doubt of it; it is so here and in every part of the world that I have heard of or seen, and it would be there, no doubt. The soil is extremely fertile; it only wants proper culture to be extremely productive, to the extent of three or four times its present produce.

WANT OF IRRIGATION.

Irrigation does exist to a certain extent, but no doubt it is the great want of the country to extend it; it is the great object to which we must look for improvememt of the country. Manure and irrigation would be the two great means of improving agriculture; they would enable the country to pay a very much greater land revenue, the profits from irrigated cultivation, as compared with dry-crop cultivation, that is to say, land cultivated by the monsoon fall of rain, are very much greater. Irrigation is carried on to a limited extent there; what we want is a general system of irrigation, which we have never yet been able to get. The extent under irrigation is extremely limited compared with the total area. We must look to irrigation as a means of preventing these horrible famines that devastate the country every thirty or forty years. When the water has to be lifted from a well, and ten acres is irrigated, it is a mere drop in the ocean compared with what we want; only ten per cent. of land is irrigated in India. It is true that on our wet lands there is a great luxuriance of vegetable growth, but we possess but a small area of such land; at the least ninety per cent. of our arable land is yet without the means of irrigation. Taking our dry

soils as a whole, their average yield of grain is certainly not one-third the average yield of the arable soils of England.

INCREASE IN PRODUCE DUE TO MANURE.

It is gratifying to find that saltpetre (nitrate of potash), an indigenous product, has given the best results, an expenditure of eighteen rupees per acre on this manure having not only nearly doubled the crop, but, after paying its own cost, left an additional farmer's profit of nearly thirty rupees per acre. The value of saltpetre has long been recognised in England; but its great cost in that country has prevented its general use. Nitrogen is always more acceptable to plants in the form of nitrate than in ammonia. Nitrate of soda is very largely used in England, and so also would nitrate of potash (saltpetre) be much used, if it could be obtained at the price at which most farmers in this country can procure it. This salt is best applied as a top-dressing when the crop is a few inches above the ground: 100 pounds or at most 150 pounds per acre is enough to apply: it should always be mixed with an equal volume of sand or some similar material, in order that it may be more regularly distributed over the ground. Bone dust stands second in my list; probably, if the continued effects of each be considered, it should stand first. Next comes carbonate of lime (chunam). An expenditure of eighteen rupees on lime was not only repaid by the increase in the crop, but a profit of nearly twenty rupees was added. Sulphate of lime (gypsum) comes next; this also not only repaid its original cost, but left an additional profit of nearly fifteen rupees per acre. The guano repaid its cost, but only left a profit of about six rupees per acre.

Financial Result	Increase due to Manure.		Value of Increase per Acre			Profit.		
	Grain	Straw.						
18 rupees per acre expended on—	lbs	lbs	Rs.	a.	p.	Rs	a	p.
Guano	540	2,808	24	4	3	6	4	3
Carbonate of lime .	702	5,922	36	9	10	18	9	10
Saltpetre	900	7,380	46	7	6	28	7	6
Bone dust	864	7,560	45	8	3	27	8	3
Sulphate of lime . . .	648	4,914	32	9	1	14	9	1

(Extract from Mr. Robertson's Report, Experimental Farm, Madras.)

RESULT OF IMPROVED CULTIVATION.

(Extract from the Report of the Superintendent, Madras Farm, 1872)

The estate now includes 250 acres of arable land. The soils, which are certainly very poor, are gradually improving, indeed in some of them a very great improvement has taken place. A fine crop of New Orleans cotton, after maize, is now growing in a field that five years ago could scarcely produce a crop of horse gram; and, if the present system of management is continued for a few years longer, nearly the whole of the land will become equally as good.

We must have small farms, or experimental stations, scattered about in each district of the Presidency, the object of each farm being to encourage and develope rather than to revolutionise local agriculture. In a grazing district, we might specially devote our attention to cattle and sheep breeding; in a mixed grazing and corn district we might turn our chief attention to dairying and stall-feeding; in a wet land district, to irrigation with a view to get the largest return with the least expenditure of water; in cotton districts, to the improvement of cotton culture, and so on.

A reduction of two head of cattle on every thirty acres of land would, if proper means were taken to preserve the manure, represent a loss of twenty-four cartloads during the year, or, as the ryot uses it, representing a diminution of at the least five acres in the area of land annually manured on each such holding. The great want of Indian agriculture is more fed stock, more and better manure; as yet we cannot hope to see the ryot engaged in feeding stock with the same object as the British farmer, but we may hope to see him adopt a more liberal diet in feeding his working bullocks, and exercise greater wisdom in utilising their manure.

As to irrigation experiments on the Madras farms, an anicut across the river Adzar, at a higher level than that now in existence, with distribution channels cut through the farms, is all that is needed to provide a perennial supply of water. Having the water-supply in our own hands, we could husband our resources, and would be in a very different position than when, as in the case of the commercial farm, drawing a supply from a tank owned by a number of cultivators, each bent on getting as large an immediate supply as possible, regardless of the duration of the supply. Such an anicut was proposed

years ago, and the ground has been inspected at least twice with the view of preparing estimates.

RENT OF IRRIGATED LAND INCREASES TO £3 PER ACRE BY THE USE OF MANURES.

(By E. C. Buck, Esq , Settlement Officer.)

The kachies are a well-known class of cultivators in the Doab, and correspond to the class known as market-gardeners in England: they are seldom found, except in the vicinity of large villages or towns in which manure is plentiful and easily accessible, because the crops which they are skilled in producing are all crops which require a large supply of manure.

By this system three crops can be produced on the same ground every year: mukka or Indian corn is grown in the rains, potatoes at the commencement, and tobacco at the end of the cold weather.

The gross outturn of these three crops is valued at between 300 and 400 rupees in some years. A potato crop sometimes weighs 150 maunds to the acre, and sells for 1 or 1-8 rupee a maund. On the other hand, the cost of cultivation is great.

The area under this triple crop in one year in the vicinity of the city was 1,312 acres. Land under such heavy cropping as this requires to be sustained by a very large supply of manure. The kachies obtain the necessary manure from the city, whence it is generally brought in sacks by buffaloes or bullocks, and deposited on the fields at end of the rains just before the potatoes are planted. The bullock-loads were counted in a very large number of fields during one season. The number per acre was seldom less than 400, never less than 300, and often much in excess of 400. Assuming that the number of the loads per acre is on an average 350, the amount of manure required for 1,312 acres is reckoned, in bullock-loads, 350 + 1,312 = 469,200. The manure deposited can hardly have been less than 400,000 loads.

A different rent is charged for land to which manure is accessible, and for land to which it is not accessible. The land close to the village site which is frequented by the villagers for purposes of nature is rented at three times the rate at which land near the boundary of the villages is rented, and land which is out of the reach of such adventitious manure. In

manured land round village sites, kachies generally pay from 15 to 20 rupees an acre.

Now, at Furrukhabad, there is a well-marked rise in the rates as the city is approached, which rise is due to the supply of manure and the presence of kachies. The rates spring from 5 and 6 rupees an acre outside the manure line to 10 and 12 rupees within it. Within the city, where manure is most abundant and accessible, they rise to 20 rupees, and in a limited number of fields lying on either side of a drain from which liquid sewage is baled out on the land, they rise to 30 and 40 rupees an acre. The difference between the rental calculated at manured rates and at ordinary rates, in and round the city, to be not less than 40,000 rupees. That this estimate is not an improbable one may be proved by a similar calculation for one of the district pergunnahs.

Mr. Elliott, settlement officer of Furrukhabad, found that the following were the prevailing rent-rates for good irrigated land in the Pergunnah of Runnouj :—

Fully manured land close to site, 10-8 rupees per acre.

Partially manured further from site, 7-8 rupees per acre.

Little or never manured land distant, 5-4 rupees per acre.

Mr. Elliott expressly states that the difference between these rates is due to difference in the supply of manure and in distance from the village site, and not to difference in natural soil.

I may state as an example of the way in which the rent of land may be enhanced, that some fields which were trenched and manured some four or five years ago at Cawnpore, and which belong to the municipality, are now rented to kachies for 40 and 50 rupees an acre, whereas previously they had only fetched 10 and 12 rupees an acre.—(Extracts from a Report on Employment of Refuse as Manure at Furrakhabad. By E. C. Buck, Esq., settlement officer, Cawnpore, October, 1872.)

THE WAYS TO GET MANURE.

(By Major F. Corbett, B.S C.)

The food eaten by men and cattle is deposited as a manure on the land close to the village, which is thus enriched, while the outlying fields are steadily becoming more sterile. This difference is more marked on bhoor or high land, which is irrigated by water from wells or canals; as, in the latter case, a certain

amount of mineral and organic matter is furnished to the land in the water. In the same way a country or district exporting grain is a loser in fertility to the extent of the fertilising substances exported in the grain. The land irrigated by the Ganges or any other canal must eventually, as well as other lands, become exhausted and useless for agricultural purposes, if as much mineral and organic matter is not supplied to the soil as is taken from it in the crops.

To collect and preserve night-soil, latrines should be made near every village—say merely pits, with walls round them, made from the earth of the pits three or four feet deep. A bedding of ashes should be laid down a foot deep, in which trenches should be dug, and a layer of the ashes placed on the deposit every day. There would be no unpleasant smell, and the whole of the human excrements, solid and liquid, would be retained for manure in a light, portable form. When one trench was filled up, another could be dug parallel to it, till the whole pit had been used, when the same process could be repeated till the pit was filled. Should there be a difficulty in procuring a sufficient supply of ashes, sand or dry earth might be used. In these pits then would be collected not only the night-soil, but the ashes, which, being mostly made from dried cow-dung, used as fuel in the villages, would, besides deodorizing the night-soil, be of themselves a valuable manure.

The soil of the bottoms of tanks and excavations near villages, being composed of the mineral and organic matters drained from the villages, is a most valuable manure, and should be dug out and used as such. The filling-in of these tanks and excavations, without using their soil for manure, would be a waste of manuring matter, by burying what is much wanted for the surface soil of the fields.

All dead cattle should be taken to the fields where wanted as manure, and buried in five or six times their bulk of earth. When the heap is used as manure, the bones should be collected and broken, and could either be mixed with other manure or used separately. Dry bones are easily broken after exposure to the sun and air in the hot weather. In England, where their value is known, bones sell at about £6 per ton, or upwards of two rupees per maund. It should be remembered that seeds sown on a rich, well-manured soil spring up into strong, healthy plants, and are less liable to disease than the weak plants grown on poor soil, and are better able to bear drought. Were

the out-fields, as well as the in-fields, well manured, famines could hardly occur in the North-Western Provinces—certainly not in places where there is a command of water, either from wells or the Ganges and other canals.

TO WHAT EXTENT MANURE INCREASES PRODUCE.

As an illustration of the value of manuring land, we may mention that the average produce of wheat to the acre in England is twenty-four bushels, but in Middlesex, where there is great facility in procuring manure from London, the average is forty bushels, and it has been known to reach even sixty-eight bushels to the acre. To give some idea of the high farming going on in England at present, we may state that last year there was imported manure to the value of upwards of £3,000,000; namely, of guano, £1,637,451, bones, £655,306; nitrate of soda, £719,244; besides many millions sterling worth of farmyard manure, refuse of gas, of woollen manufacture, lime, &c., put upon the land; and yet the cry is that England is not half enough supplied with land-fertilisers.

Compare this with the system going on in India. The farmyard manure is burnt as fuel, no artificial manures are imported, the land is continually cropped with the same products, the soil exhausted, and dearth results. The great mass of farm land in England gives back in proportion as it receives; it gets not only careful cultivation by hand, but a liberal supply of home-made or purchased manure, and purchased food for the live stock. In this country the manure-giving cattle are half starved, instead of being well fed. In England we have a new race of men of enlarged knowledge, who make farming a profession, and pursue it with advantage to themselves and to all who are connected with them.—(*Bangalore Spectator.*)

SUGAR-CANE AND MANURES.

Result of trials in Bombay, showing the weight of produce of sugar-cane per acre:—

	Tons.	cwts.
Hop manure	29	0
Peruvian guano	37	6
Dissolved bones	21	12
Super-phosphate	27	2
Nitro-phosphate	26	10
Urate	20	12
Nitrate of soda	21	11

	Tons	cwts.
No manure	19	0
Wrack or village-sweepings	41	5
Crude night-soil	48	2
Deodorized night-soil	45	3
Night-soil supplied in irrigation water	49	6

In the case in which the largest yield was obtained, *viz.*, 49 tons 6 cwts, a pit was dug in the line of the water-channel; filled with night-soil, and water made to pass through it, a few thorny branches being placed to prevent solid matter from passing.

WANTED, DEEP PLOUGHING.

(By Major F Corbett, B.S C)

Every year we hear of the cotton crop being damaged in some district or other from either excess or want of rain. Were the land deeply cultivated, so that rain could easily penetrate to the subsoil, I do not think we should hear of damage from either of these causes, and instead of getting a crop of from fifty to seventy pounds an acre, we should have one of from two hundred to three hundred pounds or even more. As it is, a great amount of the vital energy of the cotton plant is expended in forcing its roots into the hardened pan, and we have a dwarfed plant.

To obtain a deep moist soil, in the first place the land must be ploughed or stirred up deeply, so that the rain will sink into it to a depth from which it will not readily be evaporated. The rain-water will pass through the loosened soil by gravitation, leaving the soil moist, and as the upper surface soil is dried by evaporation caused by the heat of the sun, the water lost by evaporation will be replaced by water rising in the loosened soil by capillary attraction, exactly as oil rises in the wick of a lamp. The loss of water by evaporation would tend to dry the soil; but as solar heat would be absorbed by the loosened soil during the day, and radiated during the night, and the surface consequently cooled by the radiation, we should have a copious dew deposit from the vapour in the atmosphere caused by evaporation during the day.

English Ploughs and Poverty of the Ryots.—English ploughs and subsoil ploughs are, from their price, beyond the reach of natives, even if they were inclined to try them. What is wanted is an alteration in the common plough of the country, to enable

it to penetrate deeper into the soil, which alteration must be effected so cheaply as to make the improved plough not more expensive than the present one —(Extract from the paper on Irrigation in Upper India, by Major Corbett.)

EVILS OF SOWING TOO THICKLY.

Of all the evils that result from the wretched agricultural practice followed in this country, not the least is the loss produced by bad sowing, especially by sowing too thickly. Indeed, from thick sowing alone we have no hesitation in asserting our belief that on at least two-thirds of the arable land of India an annual loss is experienced, equal in amount to the full rent demanded by Government on dry land, and equal to one quarter of the rent demanded for wet land. We have known instances of native cultivators sowing as much as three hundred pounds of paddy seed on each acre of land to be cropped. The quantity of paddy seed generally broadcasted for a crop is not so much as this; it varies between one hundred and two hundred pounds per acre—a quantity still far in excess of the amount needed, for some of the best crops of country paddy we ever produced under broadcast sowing were raised from less than fifty pounds of seed per acre. The waste of seed thus caused by the low agricultural practice of the country represents in the total a heavy national loss. In broadcast sowing the seed is placed irregularly in the soil, and there is always a considerable waste from seed being left uncovered or by being covered too deeply, hence, to provide against a deficiency of plant from this course, it is necessary to sow a little more seed than would otherwise be needed. Thick sowings on rich or highly manured soil produce a close, luxuriant growth of prematurely developed plants, which generally become matted and laid long before harvest. Crops in this state are invariably attacked by mildew, under the influences of which their yield is greatly lessened. In rich and poor soils alike, thin sowing is beneficial—not too thin on poor soil, though on very highly manured soils seed can scarcely be too thinly sown. The desideratum is to produce a good standing regular crop, through which air and light may get. As a rule, thick-sown crops require an abundant supply of manure to enable them to perfect their development.—(*Agricultural Gazette of India*, September, 1873.)

POOR CONDITION OF INDIAN LIVE-STOCK.

(By Lieut.-Colonel Greenway.)

The horned cattle is small and weakly, the bones too plainly visible through the skin during the greater part of the year, the animals neglected and half starved; consequently, the animals employed for burden, draught, or ploughing are deficient both in strength and endurance, and the ratio of mortality by disease very high. The usual penny-saving economy of the Hindoo grudged the expense of breeding cattle carefully, and of feeding and tending them properly. He was not absolutely blind to the fact that additional power would do additional work, for he would at any time pay higher for a strong bullock than a weak one, but he did not believe in the possibility of improving stock, and the consequence was that the stock kept degenerating.

The Mysore cattle and the so-called Nellore breed were manifestly superior to the general run; the simple explanation being that they got more to eat. Moreover, where English gentlemen, impatient of the infamous meat they could obtain in the bazaars, took to keeping their own stock—feeding and tending the animals in a rational manner—providing them with hay against the dry season, when the poor native cattle were wandering about the jungle eating roots and twigs, and wandering miles for just enough to keep life in them—where they provided water-meadows to secure a good stock of grass, and even went the length of administering gram and cholum in their zeal for a good sirloin—it was found that the meat was most marvellously improved, so much so that it was sometimes considered too rich by very old Indians.

It was not until the Government had established periodical cattle-shows, and offered prizes for the best cattle, that anything was really done in the way of improvement. The influence of hard cash was manifest, and unmistakable improvement visible in the stock paraded at the exhibitions. Some of the draught bullocks exhibited at the cattle-show held at Addunky were fully equal to the best of the Government cattle that were trained at great expense for the service of the foot artillery. The cows exhibited were still very far in advance of the average animals of a few years before. The prices were a very satisfactory proof of this fact. £16 and £18 per pair was offered for draught bullocks, and £6 and £8 for the best cows.

If milk is the main object, the best food for cows is cholum (Indian corn) boiled and mingled with bran. A good Nellore cow, in full milk, yields on the average five quarts a day.

A considerable improvement has lately taken place in draught bullocks. Those which bring down cotton from the Cuddapah district are very superior animals; they are worth £14 the pair, and can draw half a ton in lieu of the old conventional load of seven hundred pounds. The credit of this improvement is solely due to the native traders, and it is an illustration of what may be done, and done still more effectually, when more capital and higher intelligence are employed upon the task. There is, I think, no room to doubt but that all breeds of Indian cattle, from the large and lazy Brahmin bull to the small zebu (excellent for beef)—from the powerful Mysorean to the little Travancore cow, less in size than a donkey, and as active as a goat—are capable of indefinite improvement.

Buffaloes scarcely deserve notice. The natives breed them for milk and for ploughing marshy lands, and they are sometimes used for draught; but, although possessed of great strength, are slow, obstinate, and lazy, so as to be of very little use. They are, however, more hardy than any other horned cattle, and can stand any amount of wet and exposure.

Sheep vary very much in India. On the western coast they do not thrive at all, on the eastern coast they are small and lean; the wool scanty, short, and wiry; some breeds as hairy as goats. The best specimens are found in the inland districts, especially in Mysore and Coimbatore. The sheep of the latter district are the finest in Southern India. The leg of a common bazaar sheep seldom exceeds five pounds in weight; in Travancore is usually between three and four; while the leg of a Mysore or Coimbatore sheep, grain-fed, will weigh as much as eight, or even nine, pounds. If adequate care be devoted to the breeding, as well as feeding, there is, I think, every reason to believe that an excellent stock can be insured.

REMEDY FOR REH LANDS.

(Results of analysis of the Soils and Waters upon the Western Jumna Canal)

The existence of saline strata, at least in places, seems proved by the presence of salt wells. The presence or absence of kunkur may influence the composition of the efflorescence finally formed

on the surface of the ground. *Reh* is a mixture of highly soluble salts; that water is the vehicle by which all its movements in the soil are affected, and that it is the general direction of motion of water in the soil which determines that of the reh. Hence, if by percolation the water travels upwards, the reh will be brought to the surface and left there, if downwards, the salt will descend with it; whilst in the case of an amount of water of irrigation which only wets the upper portion of the land, it would remain practically in nearly the same place, and have merely a downward and upward motion of only a few inches, sinking a little with each fresh supply of water, and being replaced at the surface by evaporation and capillary action.

In answer to the inquiry, "What can be done to improve reh soils?" various remedies are proposed—such as flooding, sweeping sub-soil, ploughing, cultivation of soda, consuming plants (if any such be known to the botanist suitable to the conditions of growth and climate); planting of trees which can live in such land as kunkur; chemical means—such as the use of nitrate of lime. But, after all, the real practical remedy appears to be irrigation, accompanied with efficient drainage. The reduction of the amount of the salts within harmless limits by their absolute separation from the soil seems the only certain cure. Water, the cause of the efflorescence, is the only effective means for its removal; that it can and does dissolve out the saline constituents is rendered evident (if proof were needed) by the results obtained from the various soils treated with it, and from the water taken from pit No. 3, every drop of water percolating through the soil, and passing away, will carry with it those portions of the excess of salts existing in the soil with which it comes in contact. This would be equally the case whether the percolation be from above downwards, from below upwards, or in a horizontal direction. Hence it is probable that the percolation of the canal water has considerably purified the strata through which it passes, and has produced a corresponding accumulation in other parts.

To obtain the full advantage of the treatment of reh soils with water, it is, of course, evident that the water must be applied in such quantity as to drain off, and that the means for its doing so must be provided. The period immediately following heavy rain would seem to be the best for flooding, so as to bring both natural and artificial agencies to work at the same time; and it is presumed that there would be less demand for

the water for ordinary irrigation at such a period.—(Extract from "Revenue Register," W. J. Ward.)

WANT OF DRINKING-WATER.

(Bengal Sanitary Commissioner's Report.)

On entering a village one is immediately surrounded by poor miserable squalid creatures, with parchment-like skins, lanky limbs, swollen feet, enormously enlarged spleens, narrow chests, shoulder-blades starting out from the body, puffy, sodden faces, and heart and arteries visibly pulsating and struggling under the influence of poisoned and deteriorated blood. In large villages hundreds of such cases are visible. It is almost impossible to imagine a more touching and saddening sight, &c. The cause of this is quite certain: it is the shocking swamp that the whole country is in in the monsoon, and the total want of wholesome water to drink in the dry season, so that the people are dependent upon what remains in the filthy pits and hollows in the ground; and the remedy is equally certain, viz., irrigation works, which always include perfect drainage in the monsoon, and an ample supply of fresh flowing river-water in every village throughout the dry season. Water is a great necessary of life, there cannot be health without a constant and full use of it, and the comfort, health, and lives of vast communities ought to receive more consideration from parliamentary committees.

IMPROVEMENT OF INDIAN AGRICULTURE.

(By Mr. W. R. Robertson, Superintendent Government Farms, Madras.)

SOIL.

In this country the so-called plough is the only implement used in working the soil, and the tillage produced is therefore very shallow and imperfect—a serious drawback in a country with a climate such as we have in most parts of India. Strictly speaking the soil is never ploughed in India, but is simply stirred or cultivated; it is never turned over, and is seldom moved to a depth beyond four inches. By passing his wretched plough several times over the land the ryot generally succeeds

in preparing a fair bed for the reception of seed—that is, a fine tilth to a regular depth—but never succeeds in producing a deep seed-bed of a uniform character. I do not mean that the seed should be placed deeply in the soil, for different kinds of seed require to be planted at different depths, but that the soil below the seed should be well and deeply tilled. Shallow cultivation, in a good showery season, may yield fair results; but crops grown on land so prepared never can stand a drought even of very moderate duration, while such crops during heavy rains, and when high winds prevail, are very liable to be seriously damaged, and they are always the first to be attacked by disease or by insects.

MANURES.

The Indian farmer does little or nothing to keep up the fertility of his land. It matters not whether his land is under wet or under dry cultivation, unless the soil he is tilling is extremely rich, the mineral matters removed by each crop must be restored to the soil, or gradual but sure exhaustion will follow. The cotton, the rice, &c , he produces and sells represents so many pounds of lime, magnesia, phosphoric acid, potash, &c., which must be restored directly to the soil, either in the shape of manure or in the irrigation water used, if the land is to go on producing remunerative crops. The native cultivator effects this when he leaves his land under fallows, either entirely to the influence of atmospheric agencies or when, by an occasional ploughing, he assists the working of these agencies. The present race of small cultivators, as long as they can get a meal of rice per day, will continue pursuing the exhausting system they now follow.

CROPS.

The amount of human food produced per acre is exceedingly small, this is due chiefly to the small size of their seed; the quantity of husk is out of all proportion to the yield of valuable matter. Take the chief food-grains—cholum, cumboo, ragi, tenney, sawmay, varagoo, &c. Of most of these the weight of a dozen seed will scarcely equal the weight of one seed of good wheat, while the dozen seeds are enveloped in five or six times the weight of husk found on a single grain of wheat. Now this Madras Presidency produces per annum less than twenty-five thousand acres of wheat, while of the other food-grains it

produces upwards of twenty million acres. It is true that some parts of the presidency are not suited to the production of this valuable crop; but it is equally true that if a better system of agriculture was adopted the area of land producing wheat in this presidency might be vastly increased. But crops such as wheat need to be skilfully cultivated, need to be grown on soils in good condition, and require manure, and these requirements the ryot cannot supply; hence he falls back on inferior crops which require little cultivation, and will grow on his poor exhausted soil without the aid of manure We may disguise the matter as we like, but the fact remains, that the ryot cannot on his exhausted upper soil grow the higher order of crops. Thus, of sugar-cane in this presidency we grow annually less than thirty thousand acres, and yet sugar-cane can be grown over the greater part of its area; but in the cropping of the ryot there is almost an entire absence of these crops, which especially require manure. There is not, I suppose, a piece of artificial pasture in the presidency in the possession of a ryot, and scarcely an acre owned by a ryot under crops specially intended to yield fodder for stock. This is a very serious matter; all the crops grown by the ryot are exhaustive. In England, Scotland, and in other countries where modern agriculture prevails, the proportion is two-thirds restorative crops and only one-third exhaustive.

LIVE-STOCK.

I assert, without any hesitation, that there is no country in which the live-stock of the farmer is so wretched as in India. It is true that in a few favoured localities the stock is moderately good; but taking the country as a whole the quality and condition of its live-stock is a disgrace to the age. There is, unfortunately, little or no attempt to improve matters. The ryot deals with his stock as with his crops—leaves all to fate. With a stock of over seven million head of cattle and over six millions of sheep, he provides neither pasture nor fodder crops for their use, but leaves them to preserve their wretched existence by such food as they can collect on unenclosed wastes, on the sides of tanks and watercourses, on fallow lands, &c. In some favoured, thinly populated localities, the position of agricultural live-stock is much better; but by far the greater number of the live-stock are kept, during two-thirds of the year, just above the starvation point. The result of such

management is, that disease is seldom absent from the herds and flocks of the ryot, producing at times frightful loss. I wish that we had statistics of the annual loss by disease amongst Indian live-stock. Facts such as these would rouse us to the actual state of our agriculture. Modern agriculture would revolutionise all this; it would provide proper food and pasturage for live-stock, while it would cultivate only the best of the indigenous breeds, and improve them by importing suitable varieties from other countries. It is a mistake to suppose that India is deficient in fodder crops. In most parts of the presidency any quantity of excellent fodder, suited in every way for live-stock, can be grown at about 3 rupees (six shillings) per ton, while, with a little skill and forethought in arranging the sowings, green fodder can in most districts be provided throughout the year, and yet fodder crops are entirely neglected by the ryot; he would rather allow his cattle and sheep to die from starvation than so far hurt his prejudice, by the unheard-of absurdity of growing on his fallow ground an acre or two of fodder for the use of his stock during the dry season.

IMPLEMENTS.

The native plough is a most imperfect implement. It does not perform the offices of a plough, instead of turning over the land, it merely stirs it, and leaves the surface in its original position; it is simply a cultivator, and one of a very bad construction. A plough turns over the ground, and exposes the roots of weeds, so that they are readily collected and removed; brings to the surface a fresh layer of soil containing the plant-food needed by the young seedlings; exposes to the effect of the sun a raw or sour under-soil which needs oxidization, and mixes intimately, through the whole volume of the soil, the matters applied to increase its fertility. Now I have over and over again proved that one operation of the mould-board plough, or, for convenience, what I may call the English plough, is equal to two operations with the native plough—that is, a pair of cattle with an English plough will, in ploughing an acre, turn over twice the volume of earth that any native plough will stir in going over the same area of land; a section of the cut made by a native plough is a triangle with the apex turned towards; the section of the cut made by an English plough is rectangular. The former stirs only a portion of soil, leaving a series of ribs untouched; while the latter turns over

the *whole* body of the soil. The ryot who owns an English plough can by its means, with one man and one pair of cattle, do as much work as his brother ryot can perform with two count-ploughs, two pairs of cattle, and two men. It is true that he will need a rather better pair of cattle than one used in many districts of this presidency, but not better than we find in Bellary, Coimbatore, and in one or two other districts. The draught of an English plough, owing to its superior construction, is, as I have often tested by the dynameter, seldom greater than the draught of a country plough, doing only half the work; but, assuming that the ryot must give 65 rupees for his pair of cattle, the outlay, including the cost of the plough, will be only 80 rupees. The two pairs of cattle he now employs cannot be valued at less than 50 rupees per pair, so that to provide them and a plough he must incur an outlay of upwards of 100 rupees against the 80 rupees expended by the owner of an English plough, while he will spend twice as much for the manual labour expended in performing the same amount of work. The pair of cattle that work the English plough will need a better class of food than is now given in many localities to ordinary plough cattle; but then only two animals will require to be fed, instead of four.

CONCLUSION.

Now it has been objected that the ryot has no inducement to buy a plough—at, say, 15 or 16 rupees—as long as the thing he calls a plough can be produced at a cost of 2 or 3 rupees. That a considerable number of our ryots cannot raise such a sum as 15 rupees I readily admit, for I know that a very large number cannot at certain seasons afford to feed, clothe, and house themselves and families properly, or even decently; but, because such a condition exists, are we to stand idly by, and wait until *all* the ryots can afford to provide themselves with the means wherewith to cultivate their soil? There are thousands of ryots able to provide these means; but they have neither the intelligence nor the enterprise to avail themselves of them; they hate all changes, and dislike everything that demands of them more exertion, or the exercise of a greater intelligence.

SUCCESSFUL RESULT OF ENGLISH AGRICULTURAL IMPLEMENTS IN INDIA.

TRIALS IN BOMBAY PRESIDENCY.—PLOUGH.

Both ploughs have been constantly tried, and with excellent results. We tried virgin grass land baked hard, and showed that it was possible to do without the moistening influence of the rains. That despair of the Indian ryot, the long-rooted dab-grass, and his enemy the bide-a-wee thorn, which his cattle will not face, and which he has to dig up by hand, are torn up without a struggle, and as if all in the way of business. Eighteen inches of the former were handed round and wondered over, and the astonishment was equal when tough young bordee plants came up root and branch. The plan we adopted was to actually plough some fields, to sow, and to await results. After the first or second ploughing applications for the loan of the ploughs came in: they were complied with as far as possible, and without restriction or demand of any kind. The ryots took them away, put their own cattle to them, and tried them in every kind of soil, without the shadow of a European near them. They were thus able to criticise and examine freely. The result is that both ploughs have been sold.

DRILL.

The drill worked to perfection. It did with one pair of bullocks and one man exactly three times the work executed by the native chowul, with its three attendants. It has, however, three faults—1st, that the iron wheels being of the narrowest sink deeply into the ground; 2nd, that it is so wide as to render its passage along most country lanes impossible; 3rd, that it is so expensive. The first can be easily cured by the substitution of broad country wooden wheels. The second must be met by taking the drill across country. The last can never be altogether removed, but I have no doubt that the machine could be made up at Ahmedabad for less than the English price, 340 rupees. The only hope of its successful introduction is by a community clubbing together for its purchase. The saving of labour is immense, but it would not pay an ordinary ryot with even a large holding, as holdings run here, to buy for himself alone.—(Extracts from a letter

from Mr. A. Borradaile, acting collector, Ahmedabad, to the revenue commissioner, N. D., 8th April, 1869.)

CLOD-CRUSHER.

The Crosshills' clod-crusher was tried at Bulsar before a large assemblage with two pairs of bullocks, and completely pulverised in one hour clods of the largest size which covered a field of ten wussas (or 12 goontas) in extent. Manual labour would have occupied two days, and cost 6 or 7 rupees to produce the same result. The machine was at once bought by the patel of Waguldhura.

THRESHING-MACHINE.

The threshing and dressing machine was similarly exhibited and approved of, and was purchased by seven cultivators, who intend to use it jointly.

PORTABLE SUGAR-MILL.

The sugar-mill and portable steam-engine to drive it could not be tried till the sugar-cane season at the close of 1869. It was then set up at Umulsar. Great difficulties were at first experienced in obtaining cane to crush, as the prejudices of the cultivators were very strong in opposition, and a very low rate was adopted. The result was that the juice was expressed at the rate of 36 maunds per hour, and altogether 564 maunds of juice were expressed and packed in 99 jars of the usual size. The sum received from the people for the work was 33 rupees, at 5 annas 4 pice per jar. It was evident that under special arrangements for fuel the work could be done cheaper, and that the juice would bear a much higher charge for expression. The juice itself also was remarkably clear, and of course obtained rapidly and simply, without the ruinous waste and delay which are inseparable from the native process. The engine and mill, which I consider to be most complete and satisfactory in every respect, were sold for full price to a party of influential persons resident in the district.

REAPING-MACHINE.

The reaping-machine I have not seen at work, as it was sent from Broach in pieces, and neither Mr. Strip nor I was able to put it together. Mr. Greaves (manager of a cotton factory), however, having been kind enough to send a mechanic, it has lately been arranged.

DESCRIPTION OF IMPLEMENTS.

	£	s
Patent double-cylinder Portable Steam Engine, 10 h.p , with spare fittings complete, Clayton, Shuttleworth & Co. . .	370	0
Horizontal Sugar Mill, 16 in. by 24 in., rollers 30 to 56½ in., with connecting gear to a steam engine and four spare pinions, W. & A. McOnie & Co., Glasgow	190	0
Threshing-machine F. 3, with a cap and poles suitable for four bullocks, fitted with a patent drum, and spare parts complete, Ransomes & Sims, Ipswich	75	0
No. 3, Dressing-machine driven from Threshing-machine, or by hand separately, with spare parts complete, Ransomes & Sims	20	0
Two Two-wheeled carriages for removing the above from place to place, Ransomes & Sims	19	0
Flour and Dressing Machine, No. 2, Ransomes & Sims .	12	10
Crosshill's Clod-crusher, 5 ft. 6 in. wide, with travelling wheel and pole for bullocks, Ransomes & Sims	23	10
Chaff-cutting Machine, Ransomes and Sims	6	10

(Extracts from a letter by T. C. Hope, Esq., Collector of Surat, to the Revenue Commissioner, N. D., 11th October, 1870.)

TRIALS WITH ENGLISH AND NATIVE PLOUGHS ON GOVERNMENT FARM, MADRAS, 1871.

English Ploughs.—The ploughs chiefly used here are those made by Messrs. Ransomes and Sims of Ipswich and Messrs. Howard and Co. of Bedford. Most of these are single-horse or pony ploughs. Those by Messrs. Howard and Co. are made of iron; they weigh eighty-five pounds, and seem well suited for light soils. They cost about thirty-five rupees each delivered here. One of these ploughs, on a free sandy loam, gave the following results when tested by the dynamometer :—

HOWARD AND RANSOMES' PLOUGHS.

Complete with Wheel and Coulter.

	lbs.
Ploughing a furrow 4 inches deep and 8 inches wide . .	168
Ploughing a furrow 6 inches deep and 9 inches wide . .	280

Without a Coulter.

Ploughing a furrow 4 inches deep and 8 inches wide . .	186
Ploughing a furrow 6 inches deep and 9 inches wide . .	308

Without either Wheel or Coulter.

Ploughing a furrow 4 inches deep and 8 inches wide . .	280
Ploughing a furrow 6 inches deep and 9 inches wide . .	336

When drawn along an empty furrow the dynamometer registered fifty-six pounds.

Thus the actual draught of one of these ploughs, when ploughing a furrow four inches deep and eight inches wide, is only a hundred and sixty-eight pounds; of this fifty-six pounds, or about thirty-three per cent., is due to the weight of the implement.

Swing Ploughs.—When used without the wheel as a "swing" plough, the draught was increased sixty-six per cent. Ransomes and Sims' ploughs have long been used on this farm. The light iron ploughs made by this firm are very similar to those sent out by Messrs. Howard and Co., and do their work in an equally satisfactory manner. We have found one of their large ploughs—the Newcastle—very useful during dry weather, when the light plough would not penetrate the ground. This plough weighs two hundred pounds, and though much too heavy for ordinary work, is nevertheless very useful under the circumstances just described. With this plough the dynamometer gave the following results:—

	lbs
Complete with Wheel and Coulter.	
Ploughing a furrow 4 inches deep and 10 inches wide . .	252
Ploughing a furrow 6 inches deep and 10 inches wide . .	392
Without a Coulter.	
Ploughing a furrow 4 inches deep and 10 inches wide . .	280
Ploughing a furrow 6 inches deep and 10 inches wide . .	406
Without a Wheel or Coulter.	
Ploughing a furrow 4 inches deep and 10 inches wide . .	336
Ploughing a furrow 6 inches deep and 10 inches wide . .	560
Complete.	
Running in an empty furrow	112

Thus, when ploughing with a furrow four inches deep and ten inches wide, forty-five per cent. of the draught registered is due to the weight of the implement.

A combined Plough, that is, one made of wood and iron, which was made on the farm, was tested in the field in which the iron ploughs were worked, with the following results:—

	lbs
Ploughing a furrow 4 inches deep and 8 inches wide . .	182
Ploughing a furrow 6 inches deep and 9 inches wide . .	280
Running in an empty furrow	65

Thus thirty-two per cent. of the draught registered is due to the weight of the plough. It is a swing-plough with wooden

stilts and pole, and, the whole of the iron-work mould-board included, consists of malleable iron. We thus avoid the loss and annoyance the breakage of castings so frequently causes. Wherever there is a village smith, the plough can be made up or repaired. This plough only weighs seventy pounds, and can be conveniently carried from field to field, and it is so constructed that the driver, while working, is always close to his cattle. To plough an acre of land six inches deep and nine inches wide with one of these ploughs, the cattle will have to travel eleven miles, and the plough will raise and turn over 869 cubic yards of earth in the operation.

Native Ploughs.—An ordinary native plough was tested in the same field; the following is the result:—

Ploughing 5 inches deep and 6 inches wide at the surface of ground, and 1 inch wide at bottom of furrow . . . 140 lbs.

To plough an acre of land with this plough, the cattle will have to travel seventeen miles, while only 400 cubic yards of earth will be turned over. The foregoing experiments prove that one of these combined ploughs will, in ploughing an acre of land, turn over nearly 900 cubic yards of earth, while the cattle will only have to travel eleven miles, and will exercise a traction force equal to 280 pounds. A native plough will only require half this draught, though it will have to travel seventeen miles to plough an acre, and will only turn over 400 cubic yards of earth. The native ploughs cut out a triangular furrow, while the furrow made by the English plough is rectangular. The result is that while the English plough cleans out its furrow and leaves the undersurface level, the native plough leaves a ridged undersurface, nearly half of the land being unploughed. Again, the English plough inverts the soil and brings up each time a fresh surface, while the native plough or cultivator, as it should be called, leaves the soil in its original position. It may be contended that as the native plough only does half of the work, and only needs half of the traction force required by the English plough, the ryot has only to pass his plough twice through his land to do the work of an English plough; but this is not the case; it will be necessary for him to plough his land over *several* times before it is in the state in which it is left by the English plough. Besides, there are several agricultural operations which the native plough, in its present shape, never can perform. And again, one English plough, with one man

and an average-size pair of cattle, will do the work of two native ploughs, two men, and two pairs of cattle. Thus the ryot, for each English plough he uses, can dispense with the services of one ploughman and one pair of cattle. True, he may have to keep his cattle a little better than at present, but this will be money well expended. I may here remark that these deductions, founded as they are on experiments made on a particular class of soil, can have no bearing whatever on soils of a different character. The cost of an English plough need not now create any apprehension in the mind of the ryot. The combined plough I have just been comparing with the native plough was made on this farm, and only cost 15 rupees; indeed, we are making them up at this price; a ryot, with his own wood and cheap labour, could probably make them up at 10 or 12 rupees each. These combined ploughs are as well suited for wet cultivation as for dry cultivation. Indeed, I am acquainted with no plough so well suited for paddy cultivation. I have tried several forms of the native plough, and have even tried one with a mould-board added, but none worked so satisfactorily. One of these combined ploughs, when ploughing in puddle for paddy, gave the following results.—

	Draught.
Ploughing a furrow 6 inches deep and 9 inches wide . .	168 lbs.

While the native plough gave the following results:—

Ploughing a furrow 6 inches deep and 6 inches wide at surface, and 3 inches wide at the bottom of the furrow . .	200 lbs.

The very defective construction of the native plough adds very greatly to its draught. Thus, in the hinder part of the plough there is a flat surface measuring eight or ten inches placed at right angle to the line of draught, this not only offers a great deal of resistance in the passage of the plough through the soil, but in wet land such an amount of mud collects on it and in the angle below the pole, that the plough is drawn through the land with great difficulty. This is not the case with ploughs provided with English-shaped mould-boards; these mould-boards offer no points for the accumulation of mud, and the plough cleans itself as it proceeds.

A PLOUGHING MATCH

Was held on the farm amongst the native ploughmen. All used English ploughs—Howard's or Ransomes'. The soil was

a light sandy loam. Each of the plots contained 1,000 square yards. The following are the results.—

1st man ploughed his plot in		. . . .	81 minutes.
2nd	do.	do.	92 "
3rd	do.	do.	88 "
4th	do.	do.	108 "
5th	do.	do.	109 "
6th	do.	do.	127 "

The land worked very freely, and the work was done early in the morning. The average width of the furrow was nine inches, and the depth between five and six inches. The work was performed in a very satisfactory manner.

HARROWS, DRILL-CULTIVATOR, CARTS.

The dynamometer has been of great value during my recent investigations into the relative capabilities of certain agricultural implements. Amongst many others the following results were obtained :—

Iron Harrows.

Dead weight	84 lbs.	62 lbs
Breadth	7 feet	$4\frac{1}{2}$ feet
Draught	224 lbs.	168 lbs.

Wood Cultivator

Dead weight	80 lbs.
Breadth	27 inches.
Draught when cultivating 5 inches deep	280 lbs.

Iron Drill Cultivator.

Dead weight	90 lbs.
Breadth	17 inches.
Draught when cultivating 3 inches deep	200 lbs

A Country Cart.

Dead weight	568 lbs.
Draught when drawn along a good level road empty	42 "
Draught when drawn along a good level road with a load of 400 bricks weighing 1,500 lbs	84 "
The same when drawn along an ungravelled road similar to the sidings on the roads in this district	356 "

A Cart built on the English Plan.

Dead weight	1,074 lbs.
Draught when drawn along a good level road empty	56 "
Draught when drawn along a good level road with a load of 400 bricks weighing 1,500 lbs.	135 "
The same when drawn along an ungravelled road similar to the sidings on the roads in this district	356 "

PLOUGHMEN AND LABOURERS.

The skill of our ploughmen is greatly improved; many of them can now handle their ploughs in a very creditable manner. They understand their construction, and can adjust them to the work they are called upon to do. They can also work the reaping-machine, the threshing-machine, and other agricultural machines and implements generally used here.

We have had a number of ploughmen under training; amongst others the following noblemen and gentlemen sent men to be trained:—

The Maha Rajah of Vizianagram,
The Rajah of Vancatagheriy,
The Zemindar of Kalastry,
The Zemindar of Ramnad, and
The Jaghirdar of Arnee.

Some of the men remained six months on the farm, while others a shorter period. This is a very satisfactory movement, and worth every encouragement.—(Extracts from Report of the Superintendent, 1871.)

COST OF SHELLING, CHAFFING, AND CRUSHING.

Maize Sheller, worked by two or three Coolies.

	Rs. a. p.	s. d.
Cost of shelling 1 ton of maize cobs by Ransomes & Sims' machine (cost 170 rupees); shelled in nine hours, 3,130 lbs. cobs	0 7 4	0 11
Cost of shelling 1 ton of maize by Ainsworth's machine (cost 38 rupees), shelled in nine hours, 4,500 lbs. cobs	0 3 8	0 5½

Bullock Power Chaff-cutter and Grain-crusher.

	Rs. a. p.	s. d.
Cost of chaffing 1 ton of maize or cholum straw by bullock-power chaff-cutter, chaffed in 90 minutes to one inch, 550 lbs. maize straw; crushed 160 lbs. gram	1 1 3	2 2
Cost of chaffing 1 ton of maize or cholum straw with manual-power chaff-cutter	2 1 8	4 2½

Cost of machine in England, 365 rupees, carriage to Madras, 85 rupees.

Combined Mill.

	Rs. a p.	s. d.
Cost of crushing 1 cwt. of gram by Ransomes & Sims' combined mill (cost 165 rupees); crushed in 1½ hour 400 lbs gram, worked by two men	0 0 4·67	0 ·58
Cost of crushing 1 cwt. of oil-cake by Ransomes & Sims' cake-crusher; broke 600 lbs. oil-cake, three men	0 0 2·61	0 ·32

The men were paid at the rate of three annas per day. Value of a pair of bullocks, 120 rupees, daily cost 12 annas; interest, wear and tear of machines, 15 to 20 per cent., is included on value charged over three hundred working days.—(Experiments, Madras Farm, 1871.)

UNFULFILLED GOVERNMENT PROMISES.

(Extracts, Dispatch, Government of India, April, 1870.)

ADVANCES TO THE RYOTS.

The Government has always, if not by extensive practice, at least by its legislation, recognised the duty which devolves upon it of giving assistance to the proprietors of land for the construction of permanent works of agricultural improvement. The security is complete, since the land is responsible for the repayment of the advances made This system is identical in principle with that which has been carried out in England and Ireland, with admirable results, by means of the Land Improvement Acts. We are satisfied that the principle may receive a much wider development in India than has hitherto been given to it. No sounder or more useful principle could be acted upon by a Government which desires to make the resources of the State available for the promotion of the wealth and improvement of the people.

The works for which advances might properly be made would commonly fall into some one of the following classes.—

(1) Wells and other works for the storage, supply, or distribution of water for agricultural purposes, and the preparation of land for irrigation.
(2) Drainage.
(3) The reclaiming of land from rivers.
(4) The protection of land from floods.
(5) The reclaiming, clearing, and enclosing of waste lands for agricultural purposes.
(6) The clearing of land from stones or other obstacles to cultivation.

It will not be difficult to devise and bring into operation a system under which advances of money might be made by the Government for works of this description, mainly through the agency of the district officers of the Government, and with

complete security against loss; and the benefits derived from such an application of capital to the permanent improvement of the land might be of almost incalculable importance.

IMPROVEMENT OF CATTLE.

Another matter in which much may undoubtedly be done by the Government is the improvement of the breeds of horses and cattle, and of other domestic animals. The Government studs have hitherto done little in this respect for the benefit of the country at large. They have been maintained primarily for military purposes. Measures are also urgently required for preventing and alleviating the destructive murrains which so frequently occur in this country, and which are lamentable and ruinous causes of injury to Indian agriculture.

Our attention has recently been directed to the fisheries of India. This is a subject which has hitherto been little cared for, but which appears likely to prove of considerable economic importance.

IMPROVEMENT OF AGRICULTURAL PRODUCTS.

We believe that it may often be the duty of the Government to act as the pioneer to private enterprise. It has done this to some extent already. The introduction of tea and cinchona cultivation into India has been mainly due to the Government. The results that are so much desired can only be secured by careful and prolonged experimental cultivation, and there can be little doubt that this may be more effectively conducted under Government supervision than by any other means.

The cereals of this country demand similar attention. Rice, wheat, and other grains are frequently of an inferior description, and, by the careful introduction and continued use of selected seed of a superior character, great improvements might unquestionably be made. The same may be said of the oil seeds, the pulses, and other products.

AGRICULTURAL EDUCATION.

In their well-known dispatch of the 19th July, 1854, on the subject of education in India, the Court of Directors referred with approval to proposals that had been made for teaching practical agriculture. Quoting the words of Dr. Mouat, they said that there was "no single advantage that could be afforded to the vast rural population of India that would equal the introduction of an improved system of agriculture." Unfortu-

nately, the means of obtaining agricultural instruction are no better now than they were when this dispatch was written fifteen years ago. In almost all civilised countries, however, in which, unlike England, the form of government is centralized, the efforts of the people are powerfully aided by the co-operation of a State department of agriculture. In India agricultural societies have been extremely useful, and they might properly receive more encouragement. But we cannot expect to obtain in this way any great results. The work that is performed by the great agricultural societies of Europe must be performed in India by the Government, or not at all. Such a department would take cognizance of all matters affecting the practical improvement and development of the agricultural resources of the colony. The periodical collection and publication of agricultural statistics is another duty which properly devolves upon the Government. The machinery for collecting such data year by year, in a regular and systematic form, already exists in many parts of India, and could be put into operation for these purposes with little or no additional expense. The formation of a special agricultural department would provide the most suitable means of controlling the forest administration. If such a department had existed, it could never have tolerated the continuance of duties such as those which are still levied on sugar exported from the North-Western Provinces across the inland customs line. These duties are transit duties of the worst description, levied on one of the most important articles of agricultural produce of Northern India. Such a department would not only deal with such question of commercial taxation, but with all branches of the statistics of trade, both external and internal, the development of growing branches of manufacturing industry, the law of patents, the mineral resources of the country, questions relating to the census and to emigration, and all other kindred subjects connected with the development of the material resources of India.

MINERAL RESOURCES.

The importance of providing cheap fuel in all parts of the country daily becomes more obvious. The search for coal, and stimulating its abundant and economical production, are matters which have assumed an altogether different character within the last few years, and they will continue to demand the earnest attention of our Government.

The development of the manufacture of iron and steel, accord-

ing to European methods, has for some years been an object of interest.

The production of petroleum, which is already carried on in several parts of India on a limited scale, suggests a possible addition to our mineral wealth, which may lead to most important results, especially in those districts where coal is not found, and wood fuel is scarce and costly.

The time may not be distant when the development of industrial arts and manufactures will proceed with a vigour that has hitherto been impossible. Evidence of this has already been given in the cotton and jute spinning and weaving mills that have sprung up and attained a healthy existence. The spread of a practical knowledge of mechanical engineering is beginning to render the use of machinery possible where only a few years ago it would have been out of the question. Encouragement given by the Government to the growth of industries which are suitable to the people and to the natural resources of the country may be productive of most valuable results, not only to India, but to other countries in which a demand for its products exists or may arise.

The establishment of a suitable system of industrial education would form a proper duty for a Department of Commerce to undertake. The preparation of popular treatises in the languages of the country on industrial subjects, and their dissemination among the artisan classes, might probably have a most useful effect.

ORGANIZATION OF THE DEPARTMENT.

We propose to constitute a Department of Agriculture and Commerce, and to place it under the supervision of a specially qualified officer, to be called Director-General of the Department of Agriculture and Commerce. Salary, 3,500 rupees per mensem.

We feel little doubt that, by undertaking a careful revision of all the local establishments which would come under the control of the new department, we should be able to meet the necessary charges on this account, without addition to the expenditure incurred at the present time.

FAILURE OF THE DEPARTMENT PREDICTED.

(*The Pioneer.*)

When all the various subjects enumerated by the Government of India have been made over to the new office, the head of the

department will find little time to take up a new line of duty for himself, and if agriculture is to be improved, he must take up a new line. The idea that any real good can be done by collecting unreliable statistics and writing reams of reports is puerile. The work to be done requires a man of practical experience, who will go about the country, see what is required, know how it ought to be done, and have power to do it. All combinations are not happy, and the combination of multifarious and incongruous duties generally fails.

(*Indian Daily Examiner.*)

Our conviction is that the new department, if it seeks to improve and extend agriculture by district officers, will miserably fail. It must have a subordinate staff of its own, trained for their work, just as our forest rangers have been trained; otherwise we shall have no more than the doubtful benefit of another Secretariat. For the administration of commerce, the present staff of the Customs Department should amply suffice.

(Mr Andrew Cassels, Merchant.)

The new department would have duties assigned to it which would be conflicting. He could not see how the direction of revenue, commerce, and agriculture could be left in the same hands. He did not believe that the agricultural interests of the empire would be so well cared for by a great department having numerous duties to perform, as they would be by a much smaller department devoted entirely to them.—(Discussion, Society of Arts, March, 1871.)

(Mr. Cheetham, late M.P., Manchester.)

With regard to the Agricultural Department, which they had been urging for some years past, he would have preferred a simple minister of agriculture. He had not much faith in boards, and he quite agreed with Mr. Andrew Cassels, that the proposed scheme would be fatal to any real progress in agriculture. Agriculture would be forgotten in the multiplicity of affairs of an immense central department situated in Calcutta.

(Sir G. Campbell, in 1872.)

The Lieutenant-Governor had hoped that the new department of the Government of India would be a practical Department of

Agriculture, which was to provide the science, the materials, the men, and the methods, by gathering them together, fitting them to the condition of this country, and showing the local administrations how to use them. His Honour thinks that the simple truth should be told, that we know nothing about agriculture; we are children in that respect, and we cannot teach others till we are ourselves taught.—(July, 1872.)

TEN MILLIONS BORROWED IN GREAT BRITAIN FOR AGRICULTURAL IMPROVEMENTS.

It appears from a Return which the Enclosure Commissioners have published that the landed proprietors of this country have availed themselves freely of their borrowing powers under the Public Drainage Acts and other public acts by which loans may be charged upon estates for agricultural improvements. The total of the moneys so borrowed amounted to £10,178,000. By far the largest sum was for drainage—viz., £7,381,000. For farm buildings the loans were £1,875,000; for labourers' cottages, £342,000. Under the Limited Owners' Residences Act £17,000 was borrowed. Beyond these sums, £563,000 was obtained for a variety of objects, such as embanking, reclaiming, enclosing, roadmaking, clearing, and planting. The whole of the £10,178,000 "is now," the Commissioners observe, "a charge upon the lands."—(Extract from *Manchester Guardian*, 12th April, 1873)

BAD CONDITION OF THE CULTIVATORS.

(Evidence before the Parliamentary Select Committee, 1871.)

A cultivator, as a rule, has no control whatever over his crop; it is entirely in the hands of the shroff and the zemindar, as a rule. The great object of the ryot in India is to get some kind of a settlement with the village loan-monger at the next harvest, and to be able to pay his rent some way or other to the landlord, to be able to get a little money, and to be sure to keep off the police at any time, if necessary. He cannot think of what would find a market, and the mahajan with whom he deals, the mortgagee who controls his industry, con-

siders only what will be the best market available for him; the ryot, therefore, is not a free agent to that extent. If a seventh of the gross produce of his land, say (taking the average amount of the land-tax that is usually estimated in India), has to be parted with in order to maintain his ancestral holding, the cultivator is not a free agent altogether; you must consider the amount of compulsion as part of the set of phenomena to be considered. The land revenue is higher than it ought to be, and it presses rather hardly upon the people —(Evidence of Mr. Geddes.)

POVERTY OF THE RYOTS.

It is certainly true that even in the immediate neighbourhood of Calcutta, large numbers of the labouring classes rarely see a silver coin, their transactions being, so far as coin is used, settled almost entirely with copper. A gold coin representing 10 or even 5 rupees (10*s.*) would be altogether beyond their reach.—(Evidence of Mr. Harrison, in answer to Q. 6,256, Select Committee's Report, vol. i. p. 276, 1872.)

THE MADRAS RYOT.

(By Mr Bourdillon)

The ryots may be divided into two principal classes: those who are comparatively well off, the few; and those who are poor, the many. Even among this more wealthy class of agriculturalists, the number of those who possess any considerable amount of property is very small. If a man of this class is able to spend 15 or 20 rupees a month, or rather if he can command a value equal to that—for he will rarely see so much money—such a man may be accounted to be very well off; and that a nett income from sources to the value of from 30 to 50 rupees a month is very rare among the agricultural class. The dwellings of this class certainly do not indicate much wealth · tiled houses are rarely seen, and masonry walls are still much more rare. The almost universal habitation has mud walls and a thatched roof, the latter of a very flimsy order. And both walls and roof are the same within as without; the rooms have no ceiling, and the floor is of simple earth, beaten hard. The value of the residence of a ryot of the more wealthy class, of whom I am now speaking, probably rarely exceeds 200 rupees, or £20. There are no couches or beds; sometimes there is seen a single rude cot which would be dear at 2 rupees. The inmates for

the most part sleep on the earthen floor, with nothing else below them but a mat or a small cotton carpet. When going a distance—to the tahsildar's or collector's cutcherry, for example—they generally travel on foot; or, in exceptional cases, usually of age or infirmity, on a pony not worth above 7 or 8 rupees.

It may perhaps be replied to all this that such are the simple habits of the country, and that the people are satisfied, and require no more. If it be meant that they choose to be poor when they might be rich, that they are satisfied with the necessaries of life when they might command some of the comforts and luxuries, then I deny the truth of the assertion. And I must add that, if true in any degree, it would only prove the ignorance and debasement of the people to whom it relates.

The foregoing description refers to the better class of ryots, men who are above the world, and well off; but the condition of the great majority is much worse. From the official list of puttahs it is seen that considerably more than half are under 10 rupees each, and in fact average only a small fraction above 4 rupees (8*s*.).

Now it may certainly be said of almost the whole of the ryots paying even the highest sums, that they are always in poverty and generally in debt. Perhaps one of this class obtains a small sum out of the Government advances for cultivation; but even if he does, the trouble that he has to take, and the time he loses in getting it, as well as the deduction to which it is liable, render this a questionable gain. For the rest of his wants he is dependent on the bazaar-man. To him his crops are generally hypothecated before they are reaped, and it is he who redeems them from the possession of the village watcher, by pledging himself for the payment of the kist. In all these accounts interest is charged on the advances made to the ryot on the balance against him.

The rate of interest varies with the circumstances of the case, and the necessities of the borrower; it is probably seldom or never less than 12 per cent. per annum, and not often above 24 per cent.; of course, the poorest and most necessitous ryots have to pay the highest.

A ryot of this class of course lives from hand to mouth; he rarely sees money except that obtained from the chetty to pay his kist; the exchanges in the out-villages are very few, and they are usually conducted by barter. His ploughing-cattle

are wretched animals, and those perhaps not his own, because not paid for. His rude and feeble plough costs when new no more than two or three shillings; and all the rest of his few agricultural implements are equally primitive and inefficient. His dwelling is a hut of mud walls and thatched roofs, far ruder, smaller, and more dilapidated than those of the better classes of ryots above spoken of, and still more destitute, if possible, of anything that can be called furniture. His food and that of his family is partly their porridge made of the meal of grain boiled in water, and partly boiled rice with a little condiment. And generally the only vessels for cooking and eating from are of the coarsest earthenware, unglazed; brass vessels, though not wholly unknown among this class, are rare.

The purely labouring classes are below these again—worse off indeed, but with no very broad distinction in condition. The earnings of a man employed in agricultural labour cannot be quoted at more than 20 rupees a year, including everything; and this is not paid in money, but in commodities. As respects food, houses, and clothing, they are in a worse condition than the class of poor ryots above spoken of. As to anything in the way of education or mental culture, he is utterly destitute of it.

CONDITION OF THE RYOTS IN OUDE, IN 1871.

Two or three years ago the chief commissioner of the province circulated questions to all the commissioners under him. The reply to these inquiries was uniform and heart-breaking. The cultivator consumes nothing of the produce of his labour but the very coarsest grain. Everything goes into the hands of the bunia, and deliverance seems hopeless. Well, having let down our plummet and sounded the depths of this misery, are we to sit still and look wistfully "to time and general laws," and coldly take leave of it? In the name of God, no! If the British Government cannot alter it, it is no Government at all. —(*I. Economist*, October, 1871.)

PICTURES OF BENGAL RYOTS, IN 1869.

The greater part of the year they spend in this way:—Under the scorching sunshine of summer, or under the heavy showers of the rainy season, or in the chilling air of winter, they are engaged in the field. But what is the upshot of such hard

labour? Deplorable penury! The greater portion of them live in straw huts; and not all have their dwellings thatched even with straw. They are doomed to pass their days with half a meal, or with fasting. In this heart-rending condition they undergo comfortless labour for twelve hours. We feel a pang to hear such things, but these wretched beings have thus to pass every day of their miserable lives. The cultivators are nowadays a little better circumstanced than formerly. Their wages were formerly 3 or 4 pice a day; now they are more than doubled.—(*I. Economist*, 1869.)

A stunted growth is the unvarying consequence of a stinted diet, and thus the rural population of Bengal has year by year become enfeebled and thereby rendered an easy prey to disease. The women, too, under such circumstances are always the first to suffer, and consequently bring forth a puny, degenerate offspring. True, the value of labour has likewise risen, but certainly not in proportion to the prices of milk, ghee, and rice, and thus in the midst of plenty the half-starved ryots are peculiarly liable to attacks of fever, which they have no strength to combat and overcome.—(*Calcutta Englishman.*)

THE BENGALEE PEASANT IN 1870.

The saddest sight probably to be seen in our Eastern empire is the Bengalee peasant Planted on a soil of marvellous fertility—returning, under the rudest husbandry, three crops a year—he lives in a condition of chronic destitution and complete ignorance. He cultivates, as a tenant, some four or five acres of land. His capital consists of a thatched hut, which generally includes a domicile for his oxen. Of these he has a pair, sometimes two, and the value of his agricultural instruments amounts on the average to 4 rupees 6 annas. He lives generally on coarse rice—fish (a mere drug in Bengal) is a rare luxury. His dress is a coarse bit of rag and a scanty sheet. As a rule he has no money whatever; but in some villages the phenomenon may be seen of a ryot possessing one, and even two, rupees. When thus wealthy he does business among his neighbours as a money-lender. To render his destitution complete, the ryot marries early. They never have any hesitation in doing this, regarding it, in truth, as essential to everlasting salvation. The mahajun advances either money or grain—principally the last. Grain advanced for seed is repayable at harvest-time, bearing one hundred per cent. interest; grain advanced

for food carried only fifty per cent. interest, repayable when the first crop is ripe. This is a miserable heavy millstone to wear round one's neck habitually. There is, to our minds, something unspeakably painful in the spectacle of these patient, silent millions, toiling on day after day, enduring cold, heat, nakedness, and hunger, with no hope before them but that of death.—(*Pioneer.*)

CONDITION OF RYOTS IN 1873 IN THE "GARDEN OF INDIA."

(By Charles W. McMuir, Esq.)

In February, 1873, I visited the Lucknow Central Jail, and was permitted to examine the cultivators who had been lately brought thither from Barabanki to be imprisoned for various offences. I asked each man the following questions:—The area of his farm, the rent which he paid, whether the latter had recently been raised or reduced; lastly, he was weighed? Thirty-three men were brought forward, being taken as they sat in a long row. There was no reason whatever for supposing that the statements were made to serve any purpose, as no complaints were preferred. It turned out that twenty-nine paid money-rents, and the entire area of their holdings was five hundred and twenty-six kucha beegas. As a rule, in Barabanki, six kucha beegas are the equivalent of one acre: let five and a half be assumed, and the entire area will be ninety-six acres, or an average of three and a quarter acres to each tenant, which is the average holding all over Oudh (*vide* Census Report). The rent paid was 970 rupees, or an average of above 10 rupees per acre. Of the twenty-nine, nineteen had had their rent raised—in some cases doubled—within the last three or four years; and the others were either men who had recently taken the lands or were under the Court of Wards. The average weight of the thirty-four was one maund and thirteen seers, or seven stone eight pounds. The superintendent of the jail informed me that ten per cent. should be deducted from the weight, as the prisoners had been fattening from three weeks to a month in the Barabanki jail; deducting only five per cent., the weight stands at seven stone three pounds; that of an average British prisoner is ten stone. Lastly, in nearly every case the prisoners had been convicted of theft or of cognate offences. None of them were muraos, kachies, or other garden cultivators, and only one was a kurmi; many of them were evidently emaciated and under-fed.

HUNGER NOT FULLY SATISFIED.

I do not hesitate to say that half our agricultural population never know from year's end to year's end what it is to have their hunger fully satisfied.

The ordinary phrase in these parts, when a man asks for employment, is that he wants half a seer of flour; and a phrase so general must have some foundation. I believe that it has this much truth in it, that 1 lb. of flour is sufficient, though meagre, sustenance for a non-labouring man. That a labouring adult can eat 2 lbs. I do not doubt; but he rarely, if ever, gets it. But take the ordinary population in a family of five, consisting of a father, mother, and three children. The father will, I would say, eat a little less than 2 lbs., the mother a little more than 1 lb., the children about 3 lbs. between them. Altogether 7 lbs. to five people is the average which, after much inquiry, I am inclined to adhere to. I am confident that with our minutely divided properties, our immense and cramped population, and our grinding poverty, any attempt at heavier taxation would result in financial failure to the government, in wide-spread distress and ruin to the people.—(C. A. Elliott, Settlement Officer, N. W. P.)

SIR G. CAMPBELL AND SIR W. DENNISON'S OPINIONS.

Sir George Campbell, in his paper on "Tenures of Land in India," published by the Cobden Club, quotes from an official authority a report made so late as 1869, about the Madras Presidency, as follows:—"The bulk of the people are paupers. They can just pay their cesses in a good year, and fail altogether when the season is bad. Remissions have to be made perhaps every third years in most districts. There is a bad year in some one district, or group of districts, every year."

CONDITION OF THE PEOPLE.

(By Sir William Dennison, late Governor of Madras.)

My feeling is that the people are deteriorating, and that we have, to a certain extent, been the cause of this. We have destroyed their native manufactures, have put a stop to the development of native talent, and are fast bringing them down to the condition of producers of raw material. I do not like to see this.—("Viceregal Life," vol. ii., p. 277.)

WANT OF A MIDDLE CLASS, SUFFICIENTLY WEALTHY AND INTELLIGENT.

The natives are by no means abstemious; those who can afford it eat much more in bulk than we do. Those castes that do not eat meat make up for it by their consumption of ghee (clarified butter) and sugar. The natives who can afford to live the best—that is, eat the most—are by far the finest men. And a very great improvement in the physique of the labouring classes in the improved districts has been observed since constant employment and good wages have enabled them to live better—that is, eat more—than their forefathers. The native, then, is only abstemious by compulsion, and, when he is forced to be so, it is so much the worse for him. Our best policy (not only for reasons of revenue) is to encourage the growth of a middle class sufficiently wealthy and intelligent to possess influence and self-confidence, and owing its aggrandisement solely to industry and the arts of peace. Such a class has as yet never existed in the East; the occasional local prosperity of a few merchants being rather a proof than an exception to the rule.—("Farming in India," by Lieut. C. Tremaney.)

CAPITAL NEEDED TO FARM ONE HUNDRED ACRES WELL.

To supply the wants of a large cantonment of one hundred acres of good loamy soil, one-fourth of this area, or twenty-five acres, to be "wet land."

Capital for Permanent Improvements.

	Rs
Levelling, Fencing, Road-making, &c.	1,500
Buildings	2,000
	3,500

Tenant's Capital.

Working cattle, 20	600
Feeding cattle, 25	300
Sheep, 100	200
Pigs and poultry	150
Implements and Carts	600
Six months' labour bill	800
Six months' food for stock	500
Manure	200
Six months' rent	75
Contingencies	75
Total	Rs. 7,000

Gross Annual Expenditure.

	Rs
Interest on permanent improvements at $7\frac{1}{2}$ per cent.	262
Interest on tenant's capital at 5 per cent	175
Rent	150
Labour, &c	1,600
Food for stock	800
Seed, manure, and contingencies	312
Say	Rs. 3,300

The buildings will be for cattle-shed containing forty loose boxes; sheep-shed, pigsties, granary, tool-store, poultry-house, cart-shed, &c As you must purchase nearly all the food at first starting, this item is perhaps heavier than it need afterwards be.—(*Agricultural Gazette of India*, 1871.)

AGRICULTURAL EDUCATION.

NO PROGRESS MADE BY GOVERNMENT.

(Lord William Bentinck, 1835)

It is impossible not to deplore the same defective state in the agricultural, as in every other science in this country. Look where you will, and you find the same results—poverty, inferiority, degradation, in every shape. For all these evils, knowledge, knowledge, knowledge, is the universal cure. We must not forget that the Government is the landlord of the country, possessing both the means and knowledge of improvement, and, putting all obligations of public duty aside, is the most interested in the advancement of the wealth and comfort of its numerous tenantry.—(Transactions, Agricultural Society of India, vol. ii. p. 211.)

(Lord Mayo's Despatch, 1870.)

It cannot be denied that Indian agriculture is in a primitive and backward condition, and the Government has not done for its improvement all that it might have done.

When the light of science has been properly brought to bear upon Indian agriculture, the results will be as great as they have been in Europe.

The duties which in England are performed by a good landlord, fall in India, in a great measure, upon the Government.

The only Indian landlord who can command the requisite knowledge and capital for the improvement of the land is the State. There is, perhaps, no country in the world in which the State has so immediate and direct an interest in such questions. The land revenue yields twenty millions of our annual income.

The means of obtaining agricultural instruction in India are no better now than they were fifteen years ago. The work that is performed by the great agricultural societies of Europe must be performed in India by the Government, or not at all.

(H. M. Secretary of State for India)

It is certain that, with the exception of the permanently settled provinces of Bengal, the Government has a direct and immediate interest in the improvement of agriculture, which is possessed by no Government in Europe.

NOT ONE AGRICULTURAL COLLEGE IN INDIA.

There are not, we regret to say, any agricultural educational institutions in this great agricultural country—a circumstance that reflects little credit either on the people or Government. You need have no fears as to not being admitted a student at the Royal Agricultural College on account of your age, as that is no disqualification. We remember several of our fellow-students over fifty years of age, and one or two lieutenant-colonels who had served thirty years in India. You will, however, find it rather costly to go to England for your agricultural education.—(*Agricultural Gazette of India*, February, 1872.)

EXAMPLE TO SHOW THE WANT OF EDUCATION.

From a very long time back it has been customary among the gowdas and ryots of the surrounding towns and villages to hold an annual cattle fair at the village of Nundipett for the purpose principally of cattle traffic. The number of cattle brought to this fair has averaged ten thousand; in some years as many as fifteen thousand animals have been brought, and it is really surprising to see the droves that come in.

Advantage was taken of this annual fair by the Mysore Government to offer a number of prizes for various classes of cattle, horses as well as bullocks; and for this purpose it was notified in all the adjacent villages, and throughout the talooks, that prizes varying from 5 to 30 rupees would be awarded, and a good competition—to judge from the numerous animals that are usually brought—was anticipated.

But people could not quite bring themselves to see that money prizes would be given for a good pair of bullocks, or a cow, without an ulterior object on the part of the Sircar, and being rather dubious over the whole affair, the poor simpletons swallowed a report that was circulated to the effect that the Sircar intended these prizes as baits to tempt and allure the ryots with their cattle, and seize all the animals without payment. There can be no doubt that this impression got abroad and spread very quickly, for some of those who had brought cattle to the fair took steps to leave by night, and on the day on which prizes were awarded (20th) not more than six hundred cattle of all kinds were shown for competition. It was indeed a very great pity that such an erroneous idea had got abroad, for after the prizes had been really given out, and the people saw and understood that no injury was intended to their property, then they began to flock in from all sides, and by Wednesday, the 22nd, more than eight thousand head of cattle had been headed. Among them were some very superior pairs of bullocks, and prices were being asked as far as 700 rupees. Good working pairs were to be had at 200 rupees, and the commissariat purchased a lot at about this average.—(*Agricultural Gazette of India*, April, 1871.)

RESULTS FROM WANT OF EDUCATION.

The Lieutenant-Governor's attention was prominently called to the subject by the magistrate-collector of Balasore, in Orissa, where the system is peculiarly inexcusable, because in that province there is not the ordinary zemindaree tenure of Bengal. There all the old ryots have long leases from Government direct, and the zemindars are still in respect of them mere rent-collectors, who have not the shadow of a right of any enhanced rent. Yet it was shown that they exacted eleven different kinds of annual cess, besides seventeen descriptions of occasional tax. Among the former were cesses to recoup themselves for the postal payments, cesses on account of the telegraph wire running through their estates (a pure imposition, as this cost them nothing), cesses to reimburse them for income-tax, and so on. There were presents exacted for the zemindari underlings; presents, very compulsory in their nature, on every occasion of a zemindars moving from home, or of a magistrate's travelling through the estate, on account of fictitious expenses that were never incurred.

In Bengal the levy of cesses may or may not be carried to such an excess as in comparatively primitive Orissa, but that the system does prevail there is no doubt.

The Lieutenant-Governor is inclined to think that while the people in Bengal do not complain, it may be better not to embark on a crusade to put down such customary illegalities, and that we may perhaps trust to the gradual enlightenment of the lower orders to enable them so far to look after their own interests. In Orissa, where the exactions are so shameless, and so little founded on any equity of any kind, it will probably be desirable to make more serious examples, when the inquiry which the Lieutenant-Governor directed is completed.—(Extract from Administrative Report of Sir George Campbell, 1873.)

GOVERNMENT EDUCATIONAL POLICY.

(Indian Finance Minister's Speech, March, 1868.)

The cost of education had increased by £118,000. The demands under this head were increasing every year, and if they were resisted the Government found itself forcibly impelled towards an increase of expenditure from pressure from without. It must be accepted as sound policy that this grant should not be allowed to eat into the resources of the State. The charge was gradually reaching formidable proportions, and, if unchecked, it would increase to such an extent as greatly to embarrass his (Mr. Massey's) successors. Under the head Ecclesiastical there was an increase of £7,000 to meet the additional pay granted to chaplains. He would mention the great expenditure incurred in military works, and especially on barracks. It was deemed expedient to push forward the construction of these buildings with the utmost rapidity. It was originally intended that this charge of eleven millions sterling should be distributed over a series of five years. The charges for such works as these—indeed for any great scheme of public works—were seldom very considerable during the first years, but always expanded as the works proceeded.

ONE PER CENT. EXPENDITURE FOR EDUCATION—FORTY PER CENT. FOR MILITARY PURPOSES!

During last year only one per cent. of the revenue of this presidency was granted for the purposes of education. Out of all the imperial taxes levied upon the people in this presidency

the government only returned one per cent. to be devoted to the cause of education, science, and art, including University, Museum, subscriptions to learned societies, &c. Now, when we compare the forty per cent. devoted to the military department, we must, I think, consider that it is somewhat surprising that people should be heard boasting that it is the pride and duty and the mission of England to educate the people of India, when such a wretched pittance as this is all that is given for the advancement and spread of education. In England a far larger grant is given by the Privy Council, in proportion to the revenue, although those grants are merely grants-in-aid to primary schools, whilst here everything connected with education, including the University, Museum, subscriptions to learned societies, &c., has to be done by the Government, the policy of which on the subject is entirely undefined.—(Extract from Report by Sir Alexander Grant, Bart., late Director of Public Instruction. Bombay, 1868.)

MEMORIAL TO THE SECRETARY OF STATE.

It is often alleged that the British Indian Government gives a charity education to its subjects; but how far this charge is grounded on fact will appear from the following State expenditure on English education in 1868-69 :—

INSTITUTIONS.	IMPERIAL FUNDS	FEES AND ENDOWMENTS	TOTAL.
	Rupees	Rupees.	Rupese
Colleges, general . . .	1,91,456	95,499	2,86,955
Government schools . .	2,29,730	2,22,016	4,51,746
Aided schools	2,00,334	3,79,404	5,79,738
Total	6,21,520	6,96,919	13,18,439

It will be thus seen that in Government colleges an amount equal to half the State contribution is raised by fees, subscriptions, and endowments; in the zillah schools a sum equal to the Government grant, and in the aided schools nearly two-thirds, come from the same sources. On the other hand, remembering that the students in this country are much poorer than the corresponding class in England, or in any European country with which a comparison can be drawn, the State

contributions in aid of those colleges and schools cannot, your memorialists submit, be withdrawn or diminished without dooming them to inevitable decay.

The principle regulalating the allotment of the public revenues to the several provinces for the purpose of education, is, in the humble opinion of your memorialists, highly unsatisfactory. In the first place, out of an income of nearly fifty millions, only £680,530 is allotted to education, and that amount is thus divided among the several provinces for 1870-71:

Provinces	Total Revenue.	Allotment for Education.
Madras	£8,010,915	£90,052
Bombay . . .	9,616,233	118,271
Bengal	15,379,708	234,384
N. W. Provinces . .	6,351,728	103,528
Punjab	3,873,749	64,909
Oude	1,590,483	26,056
Central Provinces . .	1,088,815	27,864
British Burmah . .	1,161,478	10,998

The Honourable Court of Directors, who inaugurated the present system, conclude their great despatch with these memorable words —"That any expenses which may be incurred for this object will be amply repaid by the improvement of the country, for the general diffusion of knowledge is inseparably followed by more orderly habits, by increasing industry, by a taste for the comforts of life, by exertion to acquire them, and by the growing prosperity of the people."—(Extract from Memorial of the Inhabitants of Lower Bengal, adopted at the great Educational Meeting, July, 1870.)

EDUCATIONAL GRANTS IN INDIA AND EUROPE.

Less than two per cent. of the population are readers in Bengal, and in all India only *one* in three hundred is receiving instruction. In 1863 the *Madras Times* stated that the British Government expends about one shilling per inhabitant on education, and the Indian Government one halfpenny. It is a no less instructive fact that forty per cent. of our revenue goes to support our army, while only *one* per cent. is appropriated to the education of our hundred and fifty millions of ignorant subjects. In the Northern States of America we find educational grants difficult to estimate, but evidently far surpassing the limit here proposed. They have no less than four

distinct sources of educational income. First, generous donations of land are assigned for educational purposes by Congress in every township; these are supplemented by each State legislature; and these again by the local authorities of each country town or village; and, besides these general appropriations, special grants are made to particular institutions. Secondly, three per cent. of all income from the sale of public lands is devoted to education by act of Congress. The annual sales of land from the large public domain furnish a constantly increasing educational fund. A third source is direct taxation by the State authorities. This tax varies in the different States. In Illinois it is one-fifth of one per cent. on all taxable property, *ad valorem*. A fourth source of educational income is direct taxation by the authorities of each school district. This has a close analogy to our local cess in India, only that it varies to suit the emergency, being made to supply all deficiencies of funds from the other sources. These various sources yield a magnificent educational fund, before which our educational grant in India becomes a beggarly pittance. The figures, compared with those for India, are most humiliating. The education of a hundred and fifty millions, deeply sunk in ignorance as are the masses of India, is an object of sufficient magnitude and importance to elicit the efforts and resources of the State on a much more generous scale.—(*Times of India*, 6th February, 1869.)

WANT OF EDUCATION.

(Sir T. Bazley, M P., Manchester)

The governing power of India had not thought the first necessities of mankind worthy of their attention. They had thought of the native army; they had thought of the home army; they had thought of State; but they had not thought of the comforts of the people, and they had neglected the first element of progress—they had not given them common-sense education nor the knowledge of civilisation. We must not shield ourselves by saying that we had an inferior intellect to deal with. Perhaps the Hindoos are a more timid race than ourselves; but they were our equals in intellect, and we who had the development of India in our hands were bound to spread information among the great masses of the people.—(Discussion, Society of Arts, March, 1871.)

WANT OF COMPLETE AGRICULTURAL STATISTICS.

[The following American and English examples will serve as a guide for compiling agricultural returns from each district, and for all India, on one systematic plan.]

AMERICAN EXAMPLES—VALUE OF HARVEST.

Products.	Average Yield	Average Value.	Number of Acres	Total Bushels	Value.
		Dollars			*Dollars*
Indian Corn, bush	25 9	16 32	34,887,246	906,527,000	569,512,460
Wheat . ,,	12 1	17 29	18,460,132	224,036,600	319,195,290
Rye . . ,,	13·6	17 37	1,651,321	22,504,800	28,683,677
Oats . ,,	26 3	14 74	9,665,736	254,960,800	142,484,910
Barley . ,,	24 4	31 79	937,498	22,896,100	29,809,931
Buckwheat ,,	17·8	18 68	1,113,993	19,863,700	20,814,315
			1,131,552	106,090,000	81,150,040
Total . .	. .	.	67,846,478	1,556,879,000	1,194,650,623
Potatoes . bush.	93 7	74 36	427,189	320,982,000	40,081,942
Tobacco . lbs.	751	93 82	21.541,573	26,141,900	351,941,930
Hay . tons	1 21	16 33	7,000,000	2,500,000	225,000,000
Cotton . lbs.	160 7	32 14	1,000,000		
Sugar . ,,	1,504	. .	.		
Total . .			97,816,240		1,811,674,495

EACH STATE—AVERAGE YIELD AND VALUE.

Products.	Yield	Acres	Value.	Total Value.
MISSOURI.			*Dollars.*	*Dollars*
Indian corn . bushels	30 3	2,012,112	0 57	34,751,190
Wheat . . ,,	14	382,642	1 49	7,981,930
Rye . . . . ,,	18 5	14,540	0 96	258,240
Oats . . ,,	32 9	137,659	0 43	1,947,470
Barley . ,,	24 2	6,859	1 74	288,840
Buckwheat . ,,	17 3	3,699	1 03	65,920
Potatoes . . ,,	90	11,555	0 90	936,000
Tobacco . . lbs	796	13,765	0 11·3	1,238,141
Hay . . . tons	1 40	465,714	11 00	7,172,000
Total .	. . .	3,048,545	.	54,639,731
ILLINOIS				
Indian corn . bushels	34 2	3,928,742	0 43	57,776,090
Wheat . . . ,,	11 5	2,483,478	1 20	34,272,000
Rye . . . . ,,	16·2	39,814	0 93	599,850
Oats . . ,,	31 9	1,018,150	0 39	12,666,810
Barley . . ,,	25 8	37,829	1 36	1,327,360
Buckwheat ,,	16·6	11,927	1 07	211,860
Potatoes . ,,	71	53,521	0 81	3,078,000
Tobacco . . lbs	757	20,026	0 09 1	1,379,560
Hay . . . tons	1·40	1,905,000	10 00	26,670,000
Total .	. .	9,498,487	. .	137,981,530

SUMMARY OF ACRES AND VALUE OF EACH PRODUCT IN EACH STATE.

States.	Indian Corn			Wheat		
	Acres	Bushels.	Value of Crop	Acres	Bushels	Value of Crop
			Dollars			*Dollars*
Maine	53,355	1,590,000	2,194,200	16,800	168,000	403,200
New Hampshire	43,171	1,511,000	2,160,730	21,965	257,000	621,940
Vermont	43,428	1,672,000	2,240,480	44,625	714,000	1,613,640
Massachusetts	61,945	2,292,000	3,025,440	10,709	166,000	398,400
Rhode Island	17,592	475,000	783,750	601	8,600	18,920
All States total	34,887,246	906,527,090	569,512,460	18,460,132	224,036,600	319,195,290

AVERAGE YIELD OF FOOD-PRODUCTS PER ACRE IN EACH STATE.

States.	Maize.	Wheat.	Rye.	Oats.	Barley.	Buckwheat	Potatoes.	Tobacco	Hay.
	Bush	*Bush*	*Bush.*	*Bush*	*Bush*	*Bush.*	*Bush*	*lbs*	*Tons*
Maine	29·8	10	15	22	16·1	23	130		1·02
New Hampshire	35	11·7	12·8	26·5	21·6	20	132	.	1
Vermont	38·5	16	14·8	30	23	14	135		1·02
Massachusets	37	15·5	16·1	24·1	20·1	13·2	116	1,300	1·37
Rhode Island	27	11·3	16·6	28	23	17	101		1·12
And so on for each State									

NUMBER AND VALUE OF LIVE STOCK IN EACH STATE.

States	Oxen and other Cattle			Milch Cows.*		
	Number	Average Price	Value.	Number.	Average Price	Value.
		Dollars.	*Dollars*		*Dollars*	*Dollars.*
Maine	165,013	50 70	8,336,159	131,189	51 38	6,740,490
New Hampshire	121,712	47 76	5,812,965	81,130	56 00	4,462,150
Vermont	147,690	42 47	6,272,394	186,067	50 07	9,316,374
Massachusetts	107,036	54 41	5,823,828	137,483	67 50	9,280,104
Rhode Island	20,398	72 93	1,487,626	21,815	60 00	1,308,900

* And so on for horses, mules, sheep, hogs.

EXAMPLES OF ENGLISH AGRICULTURAL RETURNS.

ACRES AND PER-CENTAGE OF CORN AND GREEN CROPS.

	Acres.	Per Cent.
CORN —		
Wheat	3,839,532	32 8
Barley	2,543,581	21 8
Oats	4,340,748	37 1
Rye	75,849	·6
Beans	534,341	4 6
Peas	364,194	3 1
Total	11,698,245	100 0
GREEN CROP —		
Potatoes	1,563,691	30 6
Turnips and Swedes	2,439,336	47·7
Mangold	364,699	7 1
Carrots	20,977	·4
Cabbages, &c., rabi, and rape	228,118	4·5
Vetches, lucerne	495,173	9 7
Total	5,111,994	100·0

PER-CENTAGE OF PERSONS ENGAGED IN AGRICULTURE.

In Great Britain, with only 6 per cent. of the population employed in agriculture, 300,000 persons are now annually added to the resident population. But in Ireland, where about 18 per cent. of the population belong to the agricultural classes, the resident population is annually decreasing in number. Calculated upon the total quantity of land returned as under arable cultivation, there would be, upon an average, 11 6 acres of arable land to every person employed in agriculture in Great Britain, against 5·8 acres, or just one-half the quantity, in Ireland.

PER-CENTAGE OF CATTLE PER 100 ACRES.

Great Britain possessed 2,150,000 horses, and Ireland 540,000, giving a proportionate number per 100 acres of land under cultivation of 6 9 in Great Britain and 3 4 in Ireland. Of cattle of all kinds there were 5,624,000 in Great Britain, or 18 1 per 100 acres, and 4,057,000, or 25·8 per 100 acres, in Ireland. Sheep numbered 27,921,000, or 90·0 per hundred acres, in Great Britain, and not more than 4,262,000, or 27·1 per hundred acres, in Ireland. There were 2,771,000 pigs, or 8 9 per 100 acres, in Great Britain, exclusive of those kept by cottagers and in towns, and 1,385,000, or 8.8 per 100 acres, in Ireland.

VALUE OF GRASSES AND HAY.

The probable value of the total crop of hay, from clover and artificial grasses in Great Britain, would amount to £9,196,000, computed upon an average yield of 1 ton per acre, and at an average price of £4 per ton. Total acreage of permanent pasture set apart for hay was 3,577,000 acres ; and at an average yield of 18 cwt. per acre, and at an average price of £3 per ton, the probable total value of the crop of meadow hay would be £9,658,000, a sum not differing largely from that of the probable value of the hay crop from clover and artificial grasses.

ACREAGE UNDER WHEAT IN EUROPE AND UNITED STATES.

In the table of the acreage for the several crops in different countries, it will be seen that at the date of the latest returns the quantity of land used for growing wheat was nearly 20 million acres in the United States, upwards of 17 million in France, about 7¼ million in Spain, 2¼ million in Austria (Proper), three-quarters of a million in Belgium, as compared with rather less than 4 million acres in the United Kingdom. Compared with the population there would be under wheat, per 100 individuals, 51 acres in the United States, 45½ in France, 44 in Spain, 11¼ in Austria (Proper), 14½ in Belgium, and rather less than 12¼ in the United Kingdom.

NO RETURNS FROM BRITISH INDIA.

To the returns for Great Britain are added, as in former years, the most complete abstract returns that can be obtained of the agricultural condition of the several British colonies and foreign countries For our important possessions in India there are not at present any available returns relating to their important agricultural resources. Considering the large supplies we obtain from British India of various agricultural and animal products, and the probability of increased supplies of Indian wheat coming to this country by way of the Suez Canal, periodical statistics of Indian agriculture would be of great interest and practical use.—(Extracts from Blue-book, 1873)

ORGANIZATION FOR GETTING RETURNS IN INDIA.

The leading maxims of all the various establishments employed (in land-tax) are care, completeness, and exactness in registering facts, and moderation in estimating what the

Government demand shall be. The result of their labours is an immense body of recorded facts—a very perfect Domesday Book, with maps showing every field, and everything necessary to a perfect land register.—(Sir B. Frere on Famines, p. 63.)

HINTS REGARDING INDIAN RETURNS.

That they should be compiled on one uniform system for each district in India, and should contain information on the following points —total area and population; population per square mile; per-centage engaged in agriculture; per-centage receiving elementary education; average amount of rainfall—maximum, minimum, months, year; depth of wells; cost of construction; cost of raising water per acre for different crops; acres irrigated by wells, tanks, and canals; acres under wet and dry cultivation; fallow, average Government assessment for dry and wet cultivation; cost of food grains, ghee, salt, fuel, &c.; cost of keeping bullocks; average rent of land for different crops; length of rivers, canals, roads (made and unmade), country tracks; cost of transit of bulky goods by each communication, including all information given in the American reports; also special information regarding the length, width, and depth of new canals actually opened, numbers of new wells, tanks constructed, and the acres irrigated, &c., by new canals, tanks, and wells, respectively; also the amount advanced to ryots by Government for improvement of agriculture.

From "Indian Economist."—While the utmost pains are being taken in several provinces to compile week by week a careful record of the price of wheat, rice, bajree, and other food staples of the country in the official maund or seer, Bombay perversely gives us the price of *atta* instead of wheat, while Madras insists upon making its quotations in the *garce*, a measure unknown out of that presidency, and of the most uncertain weight within it. The Oudh returns differ in form from those of the North-west, and these again from those of the Punjab. One government gives us weekly quotations, another monthly. One mixes up meteorological returns with its price list, another the rainfall. One gives us its statistics on tabulated foolscap, another on royal octavo. Madras screws them up two months after date into duodecimo, while Bombay sprawls them out in a continent of confusion before us.

PRINCIPAL IRRIGATION WORKS IN INDIA.

NORTH-WEST PROVINCES.

EASTERN JUMNA CANAL.

The North-west Provinces comprise a region which seems designed by nature as a great field for artificial irrigation. The rivers, after leaving the last gorge of the Himalayas, enter upon plains with a rapidly decreasing slope; and, flowing parallel to each other, they divide the country into sections, which, both as regards soil and declivity of surface, offer every requisite for irrigation.

The Eastern Jumna Canal was originally projected by Shah Jehan between 1628 and 1659, and had been partially restored in 1764 by a Rohilla chief named Zabitha Khan. In 1823 Captain Robert Smith reported upon its restoration, the scheme being to carry it centrically along the high land between the Hindaun and the Jumna, and excavation was commenced 1823. The canal was opened on 3rd January, 1830, and the water reached the Jumna again, after traversing its whole length on the 14th. Rapids formed in the sandy sections, which were remedied by falls of masonry. The Nayashahr dam, for the Eastern Canal, was formed on the Budhi Jumna with thirty sluices and a regulating bridge in the canal. The dam was built of ancient bricks brought from the old palace of Badshah Muhul. Large plantations of sál, sissú, and other trees were formed at Nayashahr for planting the banks of the canal. The canal system consists of one hundred and thirty miles of channel and six hundred and nineteen of distributaries, watering a tract about one hundred and twenty miles long by fifteen broad, between the Hindaun and the Jumna. The net revenue in

1871-72 was £32,881, giving a return of 16 6 per cent. on the outlay. The area irrigated was 192,749 acres, the season having been most unfavourable for irrigation.

GANGES CANAL.

The Ganges Canal is a purely British work occupying a field previously untouched. In 1836 Sir Proby Cautley examined the country, and in 1848 the work was commenced.

The head of the canal is two and a half miles north of the town of Hardwar, close to the foot of the Sawalâkh mountains. The next great work on the canal is the aqueduct, which takes it over the Solani river, which is eighteen miles from the head works. The main channel is 348 miles long, the branches 306, and the distributaries 3,078 miles in aggregate length, and 767,000 acres are watered by them in 5,061 villages. Irrigation commences 22 miles below the head works, and is diffused over an area 320 miles long by about 50 broad. The Ganges Canal was opened by Lord Dalhousie on the 8th of April, 1854.

Defect.—Experience has shown that, in the original design, too great a slope was given to the bed of the Ganges Canal, and considerable erosion in the bed has been the result. In 1863 Colonel Crofton was appointed to report in detail on the whole question, and his conclusions have been generally adopted by the Government. The main point to decide was whether the existing canal should be modified, so as to be able to carry with safety the whole volume of water for which it had been originally designed, or whether a second channel should be made to carry that part of the supply which the canal in its existing state could not carry with safety. The remodelling of the canal was shown to be the most economical alternative. In August 1864 an outlay was sanctioned for the protection of the falls that were most injured.

PUNJAB.—BARI DOAB CANAL.

The Punjab comprises the Bári Doab between the Bias and Rávi rivers, the Rechna Doab between the Rávi and Chenab, the Chuch Doab between the Chenab and Jhilam, and the Sind Sagor Doab between the Jhilam and the Indus.

The Bári Doab was considered the most important, as containing Amritsar, and being the cradle of the Sikh nation; and

a great canal was projected for its irrigation immediately after the annexation of the Punjab. One small permanent canal already existed in the Bári Doab. It was called the Hushi Canal, and was constructed in about 1633, by order of Shah Jehan. The English project was to bring a central canal down the high land of the Bári Doab for two hundred and forty-seven miles, receiving its water from the Rávi, where that river debouches from the lowest of the Himalayan ranges, at Madhopúr. Here there is a deep cutting through the high bank of the Rávi The original plan was that the canal should be navigable throughout, the slope being counteracted near the head by boulder rapids, and afterwards by masonry falls. The total length, including branches, was to have been four hundred and sixty-six miles. The work was entrusted to the late Colonel Dyas, with Lieutenant Crofton as his assistant They commenced work on the first thirty miles in 1850. Water was first admitted into the Bári Doab Canal on the 11th of April, 1859.

Defect in Design.—It soon became evident that the declivity of the bed, in the upper parts, was too great, the consequence being extensive channelings out in the sandy tracts, and deep holes below the falls. It was also found that the discharge from the Rávi had been overrated, and that the permanent supply was less than the works were designed to carry It became evident that to utilise the channels a supply must be drawn from other sources. The minimum supply of water from the Rávi had, in 1848, been calculated by Sir Robert Napier at 2,753 cubic feet per second. It turned out to be only 1,414, and the maximum 2,529. The sources from which the full quantity can be obtained are the river Bias, or the Rávi further down.

Remedy —Estimates for remodelling the canal were ordered to be framed in 1868. In 1870 it was resolved to complete the Kassur and Sobráon branches, but without navigation.

Total Cost and financial Result —The aggregate length of the main canal is now two hundred and twelve miles, with six hundred and ninety-two miles of rájbuhas, or distributing-channels. The total cost of the project when completed, with the branches, will be £2,000,000.

Water-rates.—Originally these rates were uniform for all crops, being Rs. 2-6-8 per acre for water given in flow, and Rs. 1-3-4 for water lifted. After much consideration, it was

resolved that the rates should vary for different crops, and be divided into four classes, the scale being for sugar cane, Rs. 6; for rice and gardens, Rs. 4-12; for wheat, barley, cotton, and indigo, Rs. 2-8.; and for other cereals and pulses, Rs.1-8 per acre. There may now be 300,000 acres receiving water from the canal; and it is estimated that the value of the crops is eleven times the price charged for water.

WESTERN JUMNA CANAL.

The first undertaking of the English was the restoration of the Feroz and Delhi canals, which was commenced in 1823; and the Western Jumna Canal system was fully developed by Colonel Colvin and Captain (now Sir William) Baker, between that date and 1843. The supply is derived from the Jumna, at the point of its debouche from the Sawalâkh hills, where the stream is rapid, the fall great, and the bed consists of shingle and boulders. At Karnal it gains the level of the high country, and soon afterwards separates into two branches, one passing on to Hansi and the other to Delhi. The Delhi branch has a very winding course, the size gradually diminishing, as water is taken off by the numerous irrigation outlets. The Hansi branch follows the line of Feroz Shah's engineer, and the pastoral villages of Hissâr are entirely dependent on it for the means of watering their cattle.

The united length of the main lines of the Western Jumna Canal is 445 miles, and in the famine of 1837-38 the value of the crops saved by its water was £1,462,800, supporting the inhabitants of 500 villages who would otherwise have died of starvation. In 1866-67 the water rate on irrigation yielded £70,000, and the area irrigated was 447,171 acres (797 villages), the aggregate length of watercourses being 728 miles. The canal has also had the effect of raising the level of the water in the wells. The total outlay up to 1871-72 was £282,517, and the net receipts for that year £74,518, being 26 per cent. on the outlay; but the indirect income is placed at £37,256, which raises the per-centage or outlay to nearly 40 per cent.

MADRAS.—GODAVARI DELTA WORKS.

The rainfall along this western shore of the Bay of Bengal is moderate, and insufficient for the satisfactory production of

rice, the crop which is most abundantly cultivated. At Vizagapatam it is forty-five inches, at Madras fifty, but further south only thirty and twenty-two.

The Godâvari works were sanctioned in 1844. At the head of the delta, at Dhauleswaram, the deep bed of the river is twenty-two feet above high-water mark, and the highest part of the delta requiring irrigation is thirty feet above the same level. From Dhauleswaram the river flows to the sea, on the crest of what may be termed a great natural embankment, six to twenty-four feet above the level of the country. The bed of the river, therefore, only required to be raised ten or twelve feet to give a perfect command and establish a working and efficient head of water. This is effected by a dam or anicut, twelve feet high, at Dhauleswaram, where the river is three and a half miles wide, one thousand yards of which is occupied by four islands.

The anicut is a substantial well-protected mass of stone, in lime cement, one hundred and thirty feet broad at the base, twelve feet high, and two and a half miles long. The delta, from the Kolair Lake to Samalkota, is a noble expanse of rich alluvial land, with an irrigable area of two thousand square miles; and the Godâvari can supply three thousand cubic feet of water during the low, and twelve thousand during the high period of the river's volume. The larger quantity may be depended on from July to October, when the rice-crop requires a constant supply of water (forty acres of rice to one cubic foot per second of water). The delta is divided into three natural sections, the first between Samalkota and the eastern Godâvari, the second between the two branches of the river, and the third from the western Godâvari to the Kolair lake. In the first section there is a channel along the river, and another, separating into two branches, to Samalkota and Cocanada.

These and all the other main lines of canal are adapted for navigation, as well as for the supply of water for irrigation. Altogether there are eight hundred miles of main channels to irrigate 780,000 acres. In 1864 an extension of the Godâvari line, completing the water communication between the Godâvari and Krishna works, was sanctioned.

The traffic on the canals of the Godâvari is of much importance to the district, and in 1871-72 was carried on by 56,471 boats and rafts.

KRISHNA WORKS.

The Krishna enters the low country at a distance of about eighty miles from its mouth; and both its banks, below Bezoarah, spread out into rich alluvial plains. The English acquired the Krishna delta in 1766, and for eighty years they did nothing, while famines periodically desolated the land. When the rains failed in 1833 not less than 200,000 people died of hunger, and the Government lost revenue to the amount of £900,000 The anicut at Bezoarah is flanked by the last hills; thence the plain stretches uninterruptedly to the sea, and to the Godâvari. The two rivers have formed the alluvial plains of the deltas, but half-way between them is the Kolair lake, a low swampy tract representing the work the Krishna and Godâvari have to do before this alluvial plain is complete. The Krishna delta covers an area of 10,000 square miles, with 1,100,000 inhabitants. The river flows to the sea on an elevated central ridge, with the country falling off gently to right and left, and a general inclination to the sea Bezoarah is exactly at the apex of the delta, where the river is one thousand three hundred yards wide, flowing between two hills. The anicut consists of a broad basis of stone thrown into the river, and allowed to assume its own natural shape, three thousand seven hundred and fifty feet long and three hundred and five broad, faced with a casing of masonry, with scouring sluices at the flanks. From the east side the main channel is divided into two branches, one to Masulipatam and the other to Ellor. The main western channel divides into the Nizapatam and Comamur branches.

Improvement.—In 1866 estimates were submitted for widening the channels so as to ensure a supply for 250,000 acres, making a total of 430,000. This work of enlarging, which is designed to develope and perfect the system of irrigation and navigation in the Krishna delta, is progressing: in 1371-72, £8,331 was expended from loan funds.

PONNAR WORKS.

The construction of the Ponnár anicut was first proposed in 1849, at the ferry at Nellor, where the river is five hundred and twenty yards in width; it was completed in 1855, but in 1857, during a hurricane, the anicut was breached for two hundred

and eighty-two feet, and the repairs were not completed until 1861. The area irrigated by the water thus obtained was 32,874 acres in 1863.

The supply from the Ponnár is precarious, so that it is obliged to be supplemented by water kept in reserve in the Nellor and other tanks, and the water is only given out on one side of the river, the levels on the northern bank being too high. There is now a project to enlarge the main or Surva-pali channel from the Ponnár anicut, and so develope the irrigation.

KAVERI AND KALERUN WORKS, TANJORE.

These are the most ancient works, both as regards the native original portion and the English improvements. At the head of the island of Seringham, near Trichinapalli, the main river divides into two branches, the southern retaining the name of Kaveri, and the northern being called the Kalerun, which latter has a larger volume, a more rapid slope. and a more direct channel, and the tendency was for the smaller stream gradually to silt up, and the whole volume to pour into the Kalerun. This would have ruined the irrigation of Tanjore. The ancient native work, called the grand anicut, was a solid mass of rough stone one thousand and eighty feet long and forty broad, stretching across the bed of the Kaveri in a serpentine form, at the lower extremity of Seringham island. It was built upwards of one thousand six hundred years ago.

In 1836, Colonel (now Sir Arthur) Cotton's plans for the development of the Kaveri irrigation were sanctioned. Before the construction of his works the area of irrigation dependent on the Kaveri and Kalerun was 669,000 acres. The great object of Sir Arthur Cotton's plans was to send the excess of water in the Kalerun back into the Kaveri, by throwing a masonry anicut across the Kalerun, the crown of which should ensure about half the supply of that branch passing into the Kaveri.

The Kalerun anicut is seven hundred and fifty yards long, divided into three parts by two islands. The effect of this work was to deepen the bed of the Kaveri, and a masonry regulating dam was carried across that river in 1845. This has given regularity of current and decease of violence in the Kaveri, and has also caused a clearing of the Kalerun; the two

streams are thus controlled in a most satisfactory manner. The Kalerun is the great drainage channel of the delta, while the Kaveri branch is a channel of irrigation only. All the numerous channels are solidly embanked, and an anicut was thrown across the Kalerun in 1836, seventy miles below Seringham, to regulate the supply for South Arcot. In 1836 the area irrigated from the Kaveri and Kalerun, in Trichinapalli, Tanjore, and South Arcot was 630,613 acres. In 1850 it was 716,524 acres. The returns on the outlay may be estimated at 23½ per cent.

DELTA WORKS.

Total areas of irrigation in the Godâvari, Krishna, Nellor, and Tanjore districts no doubt represent, very nearly, the areas irrigated by the Godâvari, Krishna, Ponnâr, and Kalerun delta works. This is—

	Acres.
Godâvari district . . .	225,032
Krishna ,, . .	144,591
Nellor ,,	176,927
Tanjor ,, ...	698,142
	1,244,692

This is probably below the truth, as the Kalerun works also irrigate tracts in Trichinapalli and South Arcot. The total area of irrigated land in the Madras Presidency amounts to 3,300,000 acres.

MINOR WORKS.—IRRIGATION WORKS IN SIND.

The Indus flows for four hundred and fifty miles to the sea, through the arid rainless country of Sind. Here irrigation is absolutely necessary to cultivation. This country is an alluvial plain, and traces of ancient channels are to be met with in almost every direction. The land is highest at the river banks. From Sakkur to the sea, the distance is three hundred miles. At Sakkur the river rushes through a narrow gorge in the limestone hills, with a descent of about four feet. At Jharrak the river is not contracted, but there is rock on either side. At Kotri hills approach on both sides, and the clay soil is deep and tenacious. The rise of the Indus commences in May, and subsides at the end of August.

The inundation canals are excavations from ten to one

hundred feet in width, and from four to ten feet in depth. None are deep enough to draw off water from the river, except during inundations. They resemble natural water-courses more than canals. The land can only be irrigated by using Persian wheels to raise the water Some of the largest canals were natural channels; others were dug by various rulers of Sind. The care of the canals consists in clearing out the silt—an operation absolutely necessary.

There is a special tax called huccaba, of three annas per biga, levied from lands watered by canals cleared by Government, to aid the cost of clearance. Sir William Merewether has represented that the huccaba is credited to revenue, and that only a portion, arbitrarily fixed without regard to real requirements, is allotted to canal clearances. He has remonstrated against this, and has represented that the canals will each year deteriorate, in proportion to deficient clearance. The sum required in 1870 was £41,168, and the grant was only £37,540; yet the huccaba amounted to £47,708, every farthing of which, he urges, ought to have been expended on the object for which it was intended.

In 1856 statute labour was abolished, and the annual work of clearances became very expensive, while insufficient funds were allowed for it. The canals are deteriorating, solely owing to the sum annually allotted being less than is adequate for the purpose.

General Strachey, in 1867, recorded that the remedy for inconveniences caused to cultivators by uncertain water supply, never under control, was the substitution of perennial for intermittent inundation canals. The area under canal cultivation in Sind is about 1,200,000 acres, and the land-tax and water charge about Rs 2-4 per acre. He thinks, if all the water was supplied by flow and none by Persian wheels, this charge might be raised to Rs. 3-4, and that the cultivated area would be doubled. He thus concurs in the views of Colonel Fyfe, who in 1855 proposed two perennial canals from the Indus at Sakkhar and Rori to Sihwán on the west, and the Fulaili on the east side, crossing all the present canals, and using them as distributing channels.

IRRIGATION WORKS, BOMBAY.

The three rivers Bhima, Krishna, and Tungabudra, rising in the western ghauts, drain the greater part of the southern dry

region, and unite to form what is usually called the Kistna, a short distance below the town of Karnal. On first issuing from the mountains, they and their tributaries traverse the thirsty lands comprised in the eastern section of the Bombay Presidency, the Deccan, and the Southern Mahratta country. The rivers are filled at the time of rains, but during the long dry season of eight months they become mere threads. The two objects to achieve are the retention of the copious supplies which run to waste during the rains, and the command of the barren lands on the sides of the valleys.

Satara Canal.—The largest of the works in the Bombay Presidency that is completed is the Krishna (the name of the upper part of the Kistna River) Canal. A masonry dam is thrown completely across the river, on a rocky bed. A canal is excavated from above the dam, in the Satara district. Its bed is four feet lower than the crest of the dam, and it is provided with scouring and regulating sluices. It then meanders along parallel to the river, with a slope of a foot a mile, being carried across the drainage of the country by suitable works, and eventually recedes from the bank, so as to command a larger area of land. In 1871-72 the area irrigated was two thousand and thirty-eight acres, giving a revenue of £955.

The *Ekruk Tank* is four miles north of the town of Sholápur, on the Adéla, a tributary of the river Bhima. The dam of earthwork, with masonry flanks, is thrown across the Adéla valley, and is seven thousand two hundred feet long, and seventy-two feet high in the centre, with a waste weir at the east end. A lake is thus formed, with an area of six and a half square miles. Thirty-five thousand eight hundred and forty acres are brought under the influence of the tank by three channels, two of them on a high level, to be used when the tank is full, for monsoon crops, which are four and eighteen miles long respectively; the other a permanent channel, twenty-eight miles long, for perennial irrigation. One of the high-level canals is now complete. The dam was completed in 1869, and the Ekruk tank is now in working order. The water was given free of charge in 1871-72, it being the first year

Púna Muta Tank and Canal.—The Púna and Kirki supply works, also within the basin of the Bhima, consist of a masonry dam of great height, and two thousand nine hundred feet long, across the valley of the Muta river, to form a reservoir. Two

open ducts lead the water to Puna and the military station of Kirki. This work was designed by Colonel Fife, and is now progressing rapidly. The centre portion of the dam has been raised for a length of two hundred and fifty feet, to a uniform level of fifty-three feet above the river bed; most of the masonry work is complete, and the Puna Canal is well advanced.

The Mudduk tank, with canals, in Dharwar, is a scheme which has been carried out at an outlay of £18,000. There are proposals for a canal from the Gokak river in Belgaum, for a canal from the Mulpurba River into the Dharwar plains, and for carrying out the Churdi project which was suggested by Sir George Wingate many years ago.

Ceded Districts.—Belary, Karnal, and Cuddapa are in the midst of the dry zone, with a rainfall at Belary of only twenty-two inches. The Tungabudra flows round the northern borders of Belary and Karnal, and offers the food-giving water to those who know how to get it. But the country beyond the mere valley of the river has thirsted for lack of sufficient water during long centuries. Often the monsoon rains fail, and then people die of hunger by scores. Yet on the banks of the Tungabudra, and within the Belary district, stood the famous city of Viziyanagar, where the old travellers Conti and Cæsar Frederick saw cool channels flowing through the streets, and groves and gardens concealing the suburbs. The Rajahs of Viziyanagar constructed dams across the Tungabúdra in 1521, and in subsequent years, by throwing enormous stones on the rocky ridges in the river bed, and leading off canals. Nine such anicuts were built, and channels with a total length of eighty-nine miles were led into the valley, to increase its fertility, and water the crops. But they were never brought to the country above, which really requires water; and this problem remained for us to solve. In 1860 the agreement was made with the Madras Irrigation Canal Company; but one important element of the enterprise was omitted, for the company's capital of £1,000,000 was raised by means of a Government guarantee to pay interest at 5 per cent. The project was sanctioned in 1861. At Sankasala a reef of rocks forms a barrier in the river, and furnishes a base on which to erect an anicut. Its height is twelve feet, and the length one thousand five hundred yards. From its right flank, the main canal is carried parallel to the river for seventeen

miles, with only one bank from sixteen to thirty-four feet high, the other being formed by the natural rise of the ground. Close to Karnul, the canal is taken across the Hindri river on a fine aqueduct. At Metacondal, seventy-two miles from Sankasala, there is a cutting a mile long, which takes the canal from the Tungabudra basin, across the water, parting, into that of the Ponnâr, descending the valley of the Kolair, to the Ponnâr itself, by a succession of locks, in a fall of two hundred and thirty-six feet. From June to November there is plenty of water from the Tungabudra, but from November to June not a drop can be abstracted from that river, without injury to the Krishna delta irrigation, so that capacious reservoirs for storage are essential to the success of the scheme. The canal is completed from Sankasala to the Ponnâr, one hundred and forty-three miles, but not so as to be capable of bearing the full amount of water, owing to weakness of construction. Another defect is that sufficient waterway is not provided for the passage of flood waters either under the canal or by surplus weirs in its banks for the escape of storm waters entering it when full.

The contract between the Secretary of State and the Company was signed on the 3rd of June, 1863, and on the 10th of July, 1864, water was first admitted from the Tungabudra into the main canal at Sankasala. In July 1864 a flood undermined a part of the anicut, and the body of the work was breached for twenty-two yards, right down to the rock. The damaged part was rebuilt in the following dry season. By May 1865 the Company had a balance of about £130,000 out of their guaranteed £1,000,000. It became apparent that the project could not be completed for the original sum, and in October, 1866, the Secretary of State granted a loan of £600,000, at 5 per cent. interest, to the Company, on the condition that if the works were not completed and placed in perfect working order by July 1871, the Company, if so desired, should surrender the whole of the works to the Government, which would pay the capital laid out on them. The main canal and works are considered by the Company, in a general sense, to have been completed by July 1871; and the Company propose to continue them, and to pay back the Government loan.

EMBANKMENTS.

In the moist belts, where there is a superabundance of rain, works of irrigation are superfluous; but works of equal importance, as regards the welfare of the people, become necessary in their place. Instead of bunds and channels to raise the water and spread it over the land, embankments are needed to preserve the crops and villages from destructive floods. There are two thousand one hundred miles of embankments under the charge of the Irrigation Department in Bengal, most of them maintained at the expense of the State. The embankments have to be made up to the proper height and section during the dry months, and carefully guarded in the rainy season.

A series of embankments is under construction along the banks of the Irawadi, in British Burmah. During the year 1870-71 the works were in abeyance, but surveys were in progress. In 1871-72 work was resumed. Two embankments were sanctioned (the Leymyethna and Zalun) which will afford protection to 150,000 acres at a total cost of 4*s*. per acre; iron sluices were provided in the Henzada embankment for passing off water lying against it after the subsidence of the floods, and several surveys were in progress.—(Extracts from B. B. M. and Material Progress of India, 1873.)

GOVERNMENT NEGLECT POINTED OUT TWENTY-FIVE YEARS AGO OFFICIALLY.

(By J. C. Bourdillon, Esq., Collector of North Arcot, Majors Sir George Balfour and F. C. Cotton, Special Commissioners.)

AREA OF THE MADRAS PRESIDENCY.

Districts.	Square Miles.	Districts	Square Miles.
Ganjam . . .	6,400	Chingleput . .	3,020
Vizagapatam .	7,650	North Arcot .	6,800
Rajahmundry .	6,050	Salem . . .	8,200
Masulipatam .	5,000	South Arcot .	7,610
Guntoor . . .	4,960	Tanjore . . .	3,900
Nellore . . .	7,930	Trichinopoly .	3,000
Cuddapah . .	12,970	Malabar . . .	6,060
Bellary . . .	13,056	Coimbatore . .	8,280
Canara . . .	7,720	Madura . . .	10,700
Kurnool . . .	3,243	Tinnevelly . .	5,700

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The British territories under this (Madras) presidency are divided into twenty districts or collectorates, and the aggregate extent of the whole is 138,249 square miles. The drainage of the whole peninsula of India, except the narrow strip at the foot of the western ghauts, is towards the east; and the larger rivers, having a considerable part of their course within the countries of the south-west monsoon, and partaking also of the north-east monsoon, are never quite dry, or only for one or two months in the year. There are some fine tanks supplied by means of such channels, such are the Veeraunum tank in South Arcot, the Cauveripauk and Maumundoor tanks in North Arcot, the Cumbum tank in Cuddapah, and many others; but in general it may be affirmed that the greater part of the flood-waters of our rivers are turned to no account, and vast bodies of water flow annually to the sea, which might be made use of to fertilise hundreds of thousands of acres now jungle or waste, to feed and maintain a vast population, and to add enormously both to the wealth of the people and to the revenue of the Government. We subjoin a memorandum, showing some particulars of four of the largest native tanks, though not absolutely the largest:—

District.	Name of the Tank.	Height of Bund	Length of Bund.	Villages Watered.	Annual Revenue to Government.
		Feet.	*Miles.*	*No.*	*Rupees*
Nellore .	Cunnigherry tank .	20	2	23	78,000
North Arcot	Cauveripaukum tank	45	4	23	43,000
Chingleput .	Chumbriunbaukum tank	25	3½	58	49,000
South Arcot	Veeranum tank .	21	9	149	114,500

FIFTEEN MILLIONS CAPITAL INVESTED IN NATIVE TANKS.

The number of tanks and channels in fourteen of the chief ryotwar irrigated districts (omitting Tanjore, from which accounts are not received, but including Kurnool) considerably exceeds 43,000 in repair, besides above 10,000 out of repair. To these belong innumerable sluices, calingalahs, anicuts, head sluices, and a variety of other works, large and small. The revenue immediately dependent on the Government works of irrigation is about 135 lacs of rupees, besides fully 15 lacs more, alienated as enam; and assuming that they now yield no more than 10 per cent. on their original cost, the amount of the capital invested in their construction may be taken at £15,000,000

sterling. The amount actually expended was probably much more, for many of the old works were constructed on very unfavourable sites, and many others were formed less with a view to profit than as perpetual memorials in honour of the founder, and at a cost very disproportionate to the probable return.

GODAVERY PROJECT ALLOWED TO SLEEP FOR HALF A CENTURY.

So long ago as before the close of the last century, an engineer (Mr. Topping) had observed the facility with which the Godavery might be made to irrigate the districts on its banks, and had brought to the notice of Government how desirable it was to throw an anicut or dam across the river, so as to raise the water, and thus make it available for that purpose. The project was allowed to sleep for half a century; but in the year 1844, the district and its revenue being in the declining state, it was again taken up. The civil engineer, Captain A. T. Cotton, first made a general report (12th August, 1844) on the feasibility of the project and the probable results; and having been directed to collect and submit more specific information, he made a second and more detailed report on the 17th April, 1845, with detailed estimates of the cost of an anicut across the Godavery River, and a more general statement of the probable cost of a system of channels and other works in connection with it, for the distribution of the water. The project received the approval of the Government, and ultimately of the Court of Directors; and the construction of the anicut, the only part of the works at first sanctioned, was commenced early in 1847. Here we must observe that a comparison of the expenses and returns up to the present time (1853) is very unfair to the project, for two reasons: 1st, because the total cost of the anicut (a work which will supply the means of irrigating the whole tract) is now shown against the gains from a very small part of that extent, in consequence of the present incompleteness of the channels for distributing the water; 2nd, because the large sums expended even on the works of distribution—in the last year at least—have not yet had time to give a return in revenue, and yet their whole cost also is included on the debit side. But even viewed under these disadvantageous circumstances, the benefits from the work are seen to be very great; we will first take the

whole revenue of the district, as shown in Statement 1. In that first year the collections were larger than in any one of the preceding eleven years, and each of the succeeding six years has shown an advance above the preceding one, with the exception of the single season 1849-50, in which there was a destructive flood in the Godavery; and even in that year the collections exceeded those of any one of the eleven years before the anicut was begun. The total expenditure on the works had been 12,65,361 rupees, and the total increase of revenue above the previous average was 19,54,803 rupees, leaving a net surplus gain of 6,89,391 rupees

This striking fact deserves special notice. To what are we to ascribe the instant rise of revenue and the sudden spring of prosperity? It could not then be wholly the effect of irrigation; the increase of irrigation, large as it has been, is not sufficient to account for the whole gain in revenue. We believe it may be found in the condition of things—viz., in the vast stimulus given to industry and production by the employment of labour and the circulation of capital involved in the expenditure of large sums in a depressed and poverty-stricken district.

REASONS FOR ADVANCING BOLDLY AND VIGOROUSLY.

This magnificent addition to the revenue is not to be gained by exaction, by trenching on the fair rights of property or industry; on the contrary, the noblest feature of all is, that vast gain to the Government is to be obtained by adding in a far higher degree to the wealth, comfort, and happiness of the people. The value of the crop on an acre of dry land does not exceed 6 rupees; but that of an acre of rice is 20 rupees.

We have given a somewhat lengthened notice to the works on the Godavery, because their great importance seemed to us to deserve it. They afford a most instructive instance of the vast benefits to be obtained by extending irrigation, and an emphatic encouragement to advance boldly and vigorously in that course of improvement. It would be unsafe to reckon upon an equal measure of success in every instance, for the circumstances of Rajahmundry were peculiarly favourable; but we are bold to declare our firm conviction that there is no district in the country in which a similar expenditure would not be largely remunerative to the Government and a blessing to the people, though not in all in the same degree.

PROOFS OF GOVERNMENT NEGLECT.

We cannot forbear recording a few observations on the very small amount of the expenditure shown in the statement. During the whole period of fourteen years included in it, the sum of the expenditure on the very important objects to which it refers was no more than £54,111 in the whole of the eighteen collectorates which possess Government irrigation works, being at the rate of the insignificant sum of £213 a year to each district. And, in point of fact, four of the eighteen districts did not participate at all the niggard expenditure, and among the four is the large and important one of North Arcot, with its 12 lacs of revenue from irrigation. And yet the result of those expenditures, even in the narrow aspect of revenue return, was such as to afford the most ample encouragement to a further advance in the same profitable course of investment, had it only been duly attended to. An examination of the list of works suggests humiliating reflections. The ancient rulers of the country, with resources of science and skill immeasurably inferior to what we can command, raised those numberless, magnificent, and valuable works, to the possession and the advantages of which our Government has succeeded It is too evident that had the present powers always ruled, the country would never have possessed these additions to its wealth, or the Government that large accession of revenue, both of which are due to the enlighted intelligence of princes whom we are accustomed to style barbarian.

LOSS TO RYOTS FROM WANT OF WATER.

In connection with the subject of loss of revenue from reglect to repair works of irrigation, it must never be forgotten that for every hundred rupees of revenue so sacrificed, to the ryot the loss is often total ruin. For if the tank or channel on which the value of his land depends is permitted to fall to decay he has no resource: he cannot even, under the existing revenue arrangements, cultivate it with dry crops; for if he did so he would have to pay the full rent for irrigated land, and the ground is therefore left untilled. But the loss to the ryots has been much more heavy; they have been reduced to much actual distress. Indeed, we cannot but think that, in neglecting or refusing to keep works of irrigation in repair, the Government commits a positive wrong. The ryot has invested his

labour and capital in the land under the tank or channel, on the implied contract that it shall be kept in efficient repair, and if that is not done, and so his property in the land becomes valueless, we think we may fairly charge the Government with breach of faith. We are induced to dwell more on this point in consequence of the order passed by Government (Revenue Department, 6th September, 1851, No. 905), directing the stoppage of the repair of two very large tanks in the Bellary district which were much damaged in the gale. The expenditure necessary to repair the tanks, that is, to recover this amount of income now lost, is £9,850, less than one year and a quarter's purchase; and this is withheld.

Our principal object in noticing this order is to point out how completely it ignores the rights of those ryots who have a property in the land watered by these tanks. They have been inherited through many generations, and have been purchased probably again and again in dependence on that right If they are now left without irrigation, they become utterly valueless under the existing revenue settlement; and even if the assessment is re-adjusted to suit them as dry land, still at least three-fourths of their value will be annihilated. And yet the question of restoring the tanks is discussed, as far as appears, without any reference to these interests. We cannot but declare that this appears to us too contracted a view. In the case of existing works the Government is in a degree morally bound to maintain them in repair, independently of, and in addition to, the consideration of revenue, for the sake of the capital which, on the faith of their virtual engagement to do so, has been invested in the land under such works.

TANK FEES PAID EXPRESSLY FOR REPAIRS.

We may here briefly advert to the "tank fees." It has been usual to regard the cost of maintaining the works of irrigation as a charge on the revenue; and it has even been represented as a part of the cost of collecting the revenue. It cannot be included in the latter without a perversion of language and confusion of ideas; and it is certain that it is not even a charge on the revenue to the extent commonly supposed; and it is doubtful whether it is so at all.

The native princes who constructed the tanks and channels of irrigation knew quite well that from their very nature they must stand in need of constant repair. They, therefore, made

a special provision for this necessity, by subjecting every acre of land irrigated to a special cess for this particular purpose, which was in some instances contributed by the ryots, and in others in equal parts from the ryots' share and the Government share of the produce, the revenue being in those times received in kind. We have not the means of determining whether this constitution of things was universal in all the provinces now forming this presidency; but it certainly prevailed generally throughout many of those in which irrigation is the most common, and it was probably universal all over the Carnatic at least.

After the assumption of the government by the English, it was determined to consolidate all the items, making up the land revenue into a single demand, and for the most part this was a fixed sum in money for each acre or each cawny, the revenue in kind being commuted In that operation the tank cess was included in the settlement, and was merged in the revenue; and the correlative duty of maintaining the works of irrigation in efficiency was fully recognised on the part of the Government. The only exception to this arrangement, we believe, was Tinnevelly, where, though the tank cess was commuted into money, and the proceeds included in the general revenue, a separate account of its amount has always been kept. These facts place the Government in a new position as to the works of irrigation.

GOVERNMENT BREACH OF FAITH.

It thus appears that it is not simply a question of policy whether the Government shall keep the works in repair, nor even that there is a merely implied engagement to do so, but that it is a positive and express obligation to be fulfilled in return for an equivalent received. It must be admitted that this duty has not been performed, and private property has suffered great damage in consequence, and it now remains, therefore, to retrieve past neglect, and bring up the works into a state of full efficiency as rapidly as possible. The fact that capital has been invested in the irrigated land on the faith of the irrigation, involves a moral obligation to maintain it; and even if that obligation were disregarded, the motive of self-interest would still remain; for we have adduced many facts to show how intimately the prosperity of the revenue is connected with the efficient condition of the works of irrigation. Indeed, in Indian

finance in general, while there are stringent orders against the expenditure of hundreds, no account whatever is kept of millions never realised, though well within our reach. We economize a writer's penknife, and take no steps to guard against a famine. There are numberless tanks, and channels, too, the waters of which, if carefully husbanded, would flow over tracts of land not irrigated now, adding to the revenue very greatly more than need be spent upon a better management.

The Ponnairy tank, in the Trichinopoly district, now in ruins for many years, is on a gigantic scale. The bund is twenty-six miles in length, and of great height, furnished with two sluices of substantial masonry, and still in good preservation; it was supplied with water from the Coleroon River by a channel sixty-two miles in length, as well as by a smaller channel from the Vellour. The whole of the country once fertilised by this stupendous work is now waste, and in great part covered with thick jungle, except a few poor villages scattered here and there, with a limited extent of cultivation attached to each.

CONCLUSION.

The Government are in the position of landlord as regards the irrigation works; they, and they only, in general can undertake the construction of such works, and there are vast numbers of undertakings, to a large amount, which would return, not 10 per cent., but 20, and even more, directly into the treasury, besides a vast addition to the comfort and wealth of the community, in advancing whose prosperity the Government has an interest (not here to speak of the duty), which does not exist in the case of the English landlord. Again, at a very moderate computation, irrigation quadruples the produce and the value of land; and thus, though acre for acre somewhat more labour is required, yet food is raised at less cost of labour, and a larger fund is left, after paying the cost of production, to be expended on other articles of comfort and convenience besides food. Then the comfort of the people at large increases, new wants spring up which were unknown before, and new branches of industry arise to minister to those wants. Thus a market is created for the surplus produce, and the producer and the consumer mutually profit by each other's prosperity; and this process can go on to an unlimited extent;

for the power of consumption is limited only by that of production, the necessary conditions being that the producers of all kinds shall be placed within reach of the consumer by good communications, and that labour shall be free. Thus capital accumulates, and with the accumulation of capital comes the love of peace and order, the cultivation and enlargement of the mind, and, in a word, civilisation.

But, in speaking of the benefits of extending irrigation, we must not omit to notice its efficacy in preventing famines. We have already pointed out the happy peculiarity of the Peninsula of India, that all its principal rivers have their sources under the influence of the south-west monsoon, which never fails; and so their waters, if duly turned to account, afford the means of preventing those distressing scarcities which would otherwise arise from the frequent, entire, or partial failure of the more uncertain north-east monsoon. In such times of dearth, the irrigated districts are not only comparatively exempt from distress themselves, but are the resource of all the country around.—(Extracts from Report, by J. D. Bourdillon, Esq., Collector, North Arcot; Major Sir G. Balfour, member of the Military Board, Major F. C. Cotton, C.E.; Blue Book, No. 407, May, 1853, price 4s. 6d.)

THE PROTECTIVE INFLUENCE OF CANALS IN NORTHERN INDIA DURING FAMINE.

(By Colonel Baird Smith, R.E., on Special Duty, 1861.)

EASTERN JUMNA CANAL.

It may be considered as a condition almost indispensable to the permanent value of rivers in connection with a system of artificial irrigation, that their sources should be beyond the influence of the vicissitudes of ordinary and, in some very sensible degree, beyond even those of extraordinary seasons. None of the Himalayan rivers escaped altogether the influence of the drought; from the Indus to the Gogra the diminution of all the great rivers was very perceptible. Doubtless the usual annual snow-fall in the upper mountains, and the rain-fall in the lower, had been much below the average of ordinary years, and thus the drainage volumes passing into the rivers were decreased. In the Ganges and Jumna the diminution seems

to have averaged about 35 per cent. of the ordinary volumes available at the driest periods of the year.

EASTERN GANGES CANAL.

Ratio of Work to Volume.—The ordinary volume available for the irrigation of the spring crop in the Eastern Jumna Canal may be estimated at 1,200 cubic feet per second. In years of average humidity, this supply will bring to maturity about 110 acres of spring crops for each cubic foot per second. In 1860-61 the average volume was 665 cubic feet per second, and the effect produced is represented by 208 acres for each cubic foot of continuous discharge; yet it was matter of general comment that the spring crops of the famine period on this canal surpassed in luxuriance of aspect, and weight of produce, those of ordinary seasons, and, with the exception of a small area, the whole were brought to a safe and abundant harvest.

The views opened by the results of this success are very encouraging. It is, of course, admitted that few stimulants to economy of water can be equal to a famine; but it is made clear by the results of this year, that considerably larger standards of work may safely be adopted than have hitherto been looked to. If 665 cubic feet per second can, under pressure, be made sufficient to ensure the maturity of say 130,000 acres of land under spring crops, 1,200 cubic feet ought to be sensibly more effective than such a volume has yet been made in our past experience of ordinary seasons. The wastage of canal water is then very great. I believe that the area of irrigation of this canal is still below the standard to which careful and efficient administration of the available supply of water in average years may bring it, and in estimating its ultimate value as a guarantee against the effects of drought, I would take at least 850,000 acres, or about 1,320 square miles, as the total measure of its protective influence.

THE GANGES CANAL.

Failure of Head Works at critical Times.—The actual effects produced by the Ganges Canal during 1860-61 are most inadequate measures of its prospective influence. During two successive seasons, one of scarcity of moisture, the other of absolute drought, the head works of the canal have failed to insure supplies of water at the most critical periods of the

autumn crops. The spring crops have been fully provided for, but this is only half the work the canal must do, and the autumn supply must be made as little liable to serious interruption as that for the spring.

Saving means Extravagance.—No time is so important to the final maturity of the autumn crops, and the first processes of the spring culture, as the two months which lie between the middle of September and the middle of November. No supplies of water, however profuse, can compensate for want of what the farmer calls the "pallaye," or first watering preparatory to ploughing. To deprive him of that narrows his operations for the season exceedingly, and by the middle of November the time for it has long passed away. There is very great risk of destroying the confidence of the agricultural classes in the efficiency of the works as protectives to their crops, and in comparison with such an effect as that, moderate pecuniary savings are in reality noxious extravagances The table showing average monthly heights of water on the gauge at *Roorkee*, and corresponding discharges of the Ganges Canal during 1860-61, conveys at a glance the whole history of the action of the canal during the famine period. Up to the end of July the supply was sufficient; but from the beginning of August to the beginning of October, when the fate of the autumn harvest hung in the balance, and when everywhere beyond the influence of artificial irrigation, it was being scorched into mere waste, the volume available ranged from 26 to 42 per cent. below the needful standard. It is not in the autumn irrigation that any possible economy of consumption can be of much practical use. The most valuable products of that season must have full supplies of water at short intervals, or they certainly die. Rice, sugar, and cotton are among them, and whatever of agricultural wealth these represent among the staples dependent on the canal, was proportionally damaged by the inadequacy of the supply at so critical a time. From October onwards the supply was ample, and the action of the canal most efficient and satisfactory.

Ultimate Capability.—I am aware of no instance in ordinary seasons when the minimum volume of the Ganges at Hurdwar has fallen below 8,000 cubic feet per second. In 1860-61 it did not exceed 5,600, of which about 300 were lost by leakage through the head weirs, and about as much more by percolation through the porous bed between Hurdwar and Roorkee,

leaving 5,000 as the standard minimum available for irrigation. In 1860-61 the whole area protected from the effects of drought would be about 1,002,264 acres, or 1,560 square miles.

The condition of the canal during the period when this effect was produced by it ought, however, to be distinctly borne in mind. None of its great branches were in action. All expenditure on these had of necessity been suspended under the financial pressure following the mutinies. It was only as special famine relief works that two of them were resumed, and their influence on the area of irrigation was of course unfelt. Hence then the work done in 1860-61 is no adequate measure of the protective efficiency of the Ganges Canal, nor can the full extent of that efficiency be reached until the original project is completed in its integrity. When so completed, the irrigated area will rise to 1,471,500 acres, and the protective influence of the canal will be felt over a total area in round numbers of 4½ millions of acres.

Permanent Head Works necessary.—For the thorough protection of that section of the Doab within which the canal system now operates, some instant action appears to me to be quite indispensable. It is of the deepest importance to the interests, both public and private, involved in the Ganges Canal, that the entire scheme should be finished and brought into full work. It was with the view of making myself acquainted with the designs for this object that, in company with Colonel Morton, Deputy Superintendent-General of Irrigation, and Mr. T. Login, Superintendent of the Northern Division, Ganges Canal, I visited the head works of the canal. The works as projected are on the most complete scale, and anything short of such a scale will, I fear, prove a failure. The work is difficult, and the contingencies are many; it is well, therefore, to allow a large margin. The agricultural property dependent upon the canal already amounts to very close on 1½ millions sterling of annual value. It will rise in time, if the agricultural community find they can rely implicitly on the virtual permanence of the supply, to fully six millions. These details may show that the expenditure proposed is not extravagant; but the true state of the case seems to me to be, that without this expenditure, be it moderate or immoderate, the action of the whole canal will be imperfect; the confidence of the people in its protective powers cannot be complete; and in every season of extraordinary aridity the supply will fail

just when water is most precious. Under these conditions, I feel no hesitation in respectfully soliciting the favourable consideration of the Government to the project for permanent head works to the Ganges Canal.

WESTERN JUMNA CANAL.

Protects only 28 *per Cent.*—Between the Jumna and the Sutlej, the Western Jumna Canal stands as yet alone as a protective agent of serious importance. Canal and well-irrigation together may be considered to have placed beyond risk of drought or famine a section of the country between the Upper Sutlej and Jumna of about 5,600 square miles in area. The whole area of the tract of country referred to, however, is fully 20,000 square miles. So that about 28 per cent. only can be regarded as at this time fairly beyond the vicissitudes of season. Much of this area is doubtless but sparsely populated, as its precarious position would lead us to expect; but within it are vast breadths of the richest soil, waiting only for a steady supply of the means of irrigation to become both populous and productive. Experience in Hurriana, which was an absolute desert at the beginning of this century, shows conclusively how sure this effect is; and the existence of the Western Jumna Canal in that region, has called into being, it may almost be said, both population and culture. The importance of placing as large a section as possible of the still unprotected area here in a condition of security will no doubt be readily recognised.

New Works required.—Among the means of doing so, the first that naturally presents itself is the improvement of the existing means of irrigation to the most practicable extent. The Western Jumna Canal, in watering during the famine period of 1860-61 very nearly half a million of acres, and supplying food grains, moderately estimated at five millions of maunds (about 6½ millions of bushels), has doubtless done noble work. But it is well known that its capacity is even greater than these illustrations of it would indicate. Its channels and its means of distribution admit of much improvement, and for years past these improvements have been subjects of discussion. I am thoroughly convinced that no money could be better invested than in extending the capabilities and correcting the imperfections of this most valuable work. That

outlay must be large to be effective, but the prospects of returns are great too. In 1860-61 the water rent on the Western Jumna Canal touched very close upon £45,000. The readjustment of the bed levels, and the improvement of the means of distribution, might be expected to raise this income to £60,000. When fully developed, I would expect its protective influence to be perhaps one-fourth greater than now, thus extending over an area of about 2,750 square miles.

THE SUTLEJ CANAL—ITS PRACTICABILITY.

The remaining great source of security to the upper section of the tract now under notice is the employment of the river Sutlej for purposes of irrigation. The practicability of so employing it has long since been demonstrated by Colonel Baker, and the necessity for its aid is now so urgent and plain that I need do little more than draw attention again to the subject. The Sutlej has the characteristics of a first-class irrigating river. Its volume is subject to no greater fluctuations than the volumes of the other rivers rising in the central Himalayas. It is altogether improbable that in the worst drought we can have it will lose more than about one-third of its ordinary minimum discharge. That discharge has been ascertained to be very nearly 5,000 cubic feet per second, and a reliable volume of 3,250 cubic feet might, therefore, always be had from this stream. Such a volume duly distributed, as the Jumna Canal supplies were in 1860-61, would be found sufficient for an area of irrigation of about 900,000 acres, and would insure against the effects of drought a tract of country having a total area of not less than 4,220 square miles. Colonel Baker estimated the cost of a canal from the Sutlej, carrying 2,500 cubic feet per second. I would increase the volume by 30 per cent., and the probable cost by 100 per cent., making the one 3,250 cubic feet per second. The returns can readily be judged of from those of the Jumna canals during the past year So estimated, the ultimate net revenue will be £6,000. This would give a return of about 13 per cent. on the capital, which is about the ordinary return given by fully developed canals of irrigation of this magnitude. The Sutlej Canal would traverse parts of the districts of Umballah, the Pattiala territories, Hissar, and Bhuttiana, thus including a section of country in which the strengthen-

ing effect of a zone of prosperous irrigation would be of inestimable importance.

HOW TO PROCEED.

The proportion of the whole area which would, by these various means, be secured against the effects of drought, would be very nearly 50 per cent. But of the unprotected portion the barren waste represents a very large share. The cultivated or culturable land may be approximately estimated at 13,000 square miles, and for a little over 10,000 square miles a sufficient provision for irrigation will have been made when the works suggested have been completed. It is not at all necessary to suppose that a canal from the Sutlej at a high level will exhaust the capabilities of that river for agricultural purposes Such a canal would be the first and best use of its waters, but hereafter it may become both expedient and practicable to draw other lines from lower levels, which, though not so efficient, nor so reliable in their action, may still become very valuable, and give additional guarantees for the security of the tract. If, however, the Western Jumna Canal be remodelled, the Sutlej Canal executed, and such further use made of the waters of minor rivers, whether for direct irrigation of the lands on their banks or for the supply of reservoirs, as may be found practicable, the gradual extension of irrigation over the remainder of the country may safely be left for future consideration. As regards the capabilities of the section of the North-Western Provinces west of the Jumna, there is not much to be said. There are, however, considerable capabilities in this region. It has some rivers, which, though scarcely to be called perennial, have small volumes in the spring. and great ones in the autumn. There are noble sites for large artificial lakes in many localities, and numerous means of feeding them.

Rohilkund.—This province has considerable capabilities, and the demand for increased protection may be met to an important extent. In 1860-61 the canal irrigation extended over 91,995 acres, on which were reared crops of the value of £393,122. The canals, whence the water for this area is derived, are virtually concentrated in the district of Bareilly. To all practical intents and purposes, means of irrigation have to be created elsewhere. The supplying rivers are all small,

and their volumes not absolutely certain, though rarely failing wholly. The number of such rivers is very great.

Rivers Ramgunga and Sardah.—In 1556-57 I had the river Ramgunga carefully examined, and a project for a canal from it was then prepared by Mr. James Parker, Superintendent of the Upper Central Division Ganges Canal. To use the stream for the irrigation of the country on one or other of its banks would be most desirable, and as the ground at the base of the Himalayas, near the *débouché* of the Ramgunga, has excellent sites for storage reservoirs, the great supply of the rainy season might there be gathered, and retained for use during the spring. The only other large stream whence a supply might be drawn is the Sardah, or Gogra, on the extreme eastern frontier of the province. It possesses the main characteristics of a first-class irrigating stream. Its supply is large and constant, and it may be inferred that its levels are good. But all these points wait investigation, and it is sufficient at present to indicate the expediency of this being made.

NECESSITY OF STORING WATER.

Admitting the imperfections of the minor river lines as means of irrigation, I am still of opinion that considerably larger use might be made of them than at present. There is, even in the worst season of drought of which we have yet had experience, a large volume of water available. I estimate the outfall of drainage water through the various drainage lines of the Doab, during the rainy season of 1860-61, miserably defective though it was, at not less than 15,000 cubic feet per second, between the beginning of June and end of September. In ordinary years the volume is four or five times as great; but even the minimum shown above is more than double the volume required to place the unprotected third of the total area of the Doab beyond the risk of further suffering from drought. The problem is, to store and distribute this volume in such manner as best to meet the want of the farmers The question is not one, of course, that can be disposed of without close and careful local inquiry; but I would be very much disappointed if such inquiry did not result in the beneficial employment of a very considerable portion of this water, which now runs wholly to waste.—(Extracts from B. B., Report on Famine, N. W. P. 1860-61.)

MORE THAN A MILLION ACRES WERE WATERED BY THE GANGES CANAL DURING THE FAMINE, 1868-69.

(Extracts from the Report of Superintending Engineer.)

Crop.	1868-69 Acres	1868-69 Per cent.	1867-68 Acres	1867-68 Per cent.
Sugar-cane (annual)	60,664	5 63	55,232	10 36
Khureff —				
Cotton . .		4·10	. . .	1·05
Indian corn .		2 89	. . .	0 33
Indigo . .	293,604	7 00	. . .	14 18
Rice . .		4·02	. . .	6·82
Miscellaneous		8·28	. . .	1·97
Total acres	293,604	26 29	129,906	24 35
Rubbee :—				
Barley		22·47	. . .	16·52
Gram		3·71	. . .	2·49
Wheat		38 78	. . .	43·41
Miscellaneous . . .		3·12	. . .	2·87
Total acres	734,132	68 08	348,318	65·29
Total of two Seasons :—				
Annual crop	60,664	5 63	55,232	10·36
Khureff . .	293,604	26·29	129,906	24·35
Rubbee .	734,132	68·08	348,319	65 29
Grand total acres	1,078,400	100 00	533,457	100·00

Villages taking water was—	1868-69	1867-68
During Khureff .	4,634	3,994
During Rubbee crop	5,795	4,520

INFLUENCE OF INCOMPLETE CANAL, BENGAL FAMINE, 1874.

With regard to the benefits of irrigation in India a striking instance was seen in the visit of the Viceroy to the Soane Works at Dehree during the famine in 1874. He there found 100,000 acres irrigated in a few weeks by the new works in their unfinished state, not a quarter of the project being yet completed. The value of a single crop of rice at the famine price of 1*d.* a pound, £5—while the cost of works per acre was £2, including a canal for navigation, seventy yards broad at the head (which is opened for some eighty miles) and 8 ft. deep, fitted for steamers of 250 tons.

ABSTRACT OF OFFICIAL REPORT, 1874.

The area watered by the Soane Canal had risen to 157,548 acres. It was thought that the water could now be shut off for the rest of the season, so that the masonry works might proceed. This was under inquiry.

The Kana Nuddee works had largely benefited a part of the Hooghly district. The people were stated to be overjoyed with the introduction of water from the Damooda River, calling it "a gift from God."

Government would have to provide for the support of 2½ millions, or 10 per cent. of a population of 25,000,000 for seven months. To meet this possible demand 80,000 tons of rice had been ordered beyond sea by the Government of India, and 38,000 tons had been ordered in India by the local government. In all, 1,18,000 tons had been ordered. The *first cost* of these supplies would amount to *three millions* sterling, an expenditure which the Government had not hesitated to incur for the purpose of alleviating the effects of the famine. —(From B. B., Bengal Famine, 1874.)

The Viceroy stated that the present drought (in 1874) in North Behar, and former droughts within a short period of time, had drawn the attention of Government to the necessity of a system of irrigation *which would provide against the recurrence of similar calamities.* Surveys had accordingly been ordered.

In Behar, embankments on the river Gunduck were authorised.—(Extracts from B. B., Bengal Famine, C. 993, 1874.)

THE STAPLE FOOD OF THE PEOPLE.

There is a general erroneous impression that rice forms the staple article of food through all India; whereas all through the Punjab and the North-West Provinces wheat is the staple just as much as in England, and more than 60 per cent. of the land irrigated is wheat alone. There are generally two crops in the year: the cold-weather one sown about October and reaped in April, which consists of cereals and other productions of a temperate climate; and the rainy-weather crop, sown about June and reaped in September and October, consisting of rice and other tropical products. Sugar-cane takes nearly a whole year to mature.

The average rent of unwatered land (North-West Provinces) is about 6*s*. per acre, and of watered land 23*s*. to 24*s*.

THE PROTECTIVE INFLUENCE OF CANALS IN SOUTHERN INDIA.

(By Sir Arthur Cotton, R.E., 1874)

TANJORE, THE DELTA OF THE CAUVERY.

There had been an extensive system of irrigation in Tanjore from ancient times, but in 1827 there began to be great alarm about the state of this district, and it was seriously feared that the Cauvery branch of the river might entirely desert the district, the whole water of the Upper Cauvery flowing to the sea, by the larger branch, the Colleroon. It was in consequence of this alarm that a complete new system of works was commenced on the 1st January, 1830, intended not only to prevent the evils feared, but also to put the whole system of irrigation in a far more perfect state, both as respects supply and area, than it had been before. The whole expenditure during the forty-three years past has been very small. During the first seven years of this period only £11,000 a year was spent, including repairs, so that the new works could not have cost above £50,000 in that time. They have been continued ever since at intervals. The total cost may have been £200,000 or £300,000. The improvement of the district has been unbroken, and not only has there been no famine in the Delta, but it has constantly supplied neighbouring districts in times of scarcity in them.

GODAVERY DELTA WORKS.

The next district in which a new system of irrigation was introduced was Godavery, and here navigation was included. The works have never been completed, but up to this time only 480,000 acres have been irrigated out of about 1,000,000 in the Delta.

With reference to famine, there has not been the smallest fear of the district for the twenty-five years since the works were begun, and it secures a vast extent of the surrounding country. And these works yet admit of a further improvement. Though there is water in the canals all the year, yet they cannot nearly be kept full in the dry season. If water were stored in the Upper Godavery, not only would 500 miles of that river and the Wurdah be kept in an effective state for navigation in the dry season, but the water would be of great

value in the Delta, both for improved navigation and for extension of the second-crop cultivation. This water could be supplied at a very moderate cost.

KISTNA DELTA WORKS.

These works are exactly similar to the Godavery. The works were projected by Colonel Lake, of Kars. The expenditure has not been so great—about £300,000. The increase of produce per acre is estimated higher there on account of the superior fertility of the soil, owing no doubt to the Kistna flowing through a limestone country. By the last return 200,000 acres were watered, giving £2 per acre for a single crop, besides very cheap transit. The direct returns in water-rate on 200,000 acres at 4 rupees, £80,000, is 27 per cent., besides tolls. But the works are in a much more backward state than those of the Godavery. There has been most grievous mismanagement in not completing these works. It is now nearly twenty years since the great Weir and other main works were completed, and the water has not yet been distributed to one-fifth of the rich land commanded. What can be more unaccountable than this—that works which from the very first have yielded such enormous results are left for many years a quarter finished, and nothing could induce the Government to grant the money for their completion? When completed, the results will be fully equal to those of the Godavery.

OPINION OF SIR C. TREVELYAN.

With the main point of the paper he cordially agreed, being satisfied that with a thorough system of irrigation famines would be impossible. This might be illustrated by Sir Arthur's own works—the great aqueduct on the Godavery and on the Krishna. It was truly magnificent to see those two great rivers stopped in their course, and the water lifted up so as to be available for irrigating the deltas of the respective rivers, and also for navigation. In fact, he himself went direct from the steamer right into the mouth of the high-level canal and up the Godavery without any transhipment. If all India were treated in the same way, famine would be impossible. In conclusion, he said that though some persons might differ from Sir Arthur Cotton on some points, all would agree that his past services to that country had been such that he would be always

regarded as one of the greatest benefactors of India.—(*Society of Arts Journal*, April, 1874.)

OPINION OF SIR BARTLE FRERE.

It is the fashion to deny the facts regarding the results of irrigation works on which Sir Arthur's calculations are based, but I feel certain the more they are tested the more clearly it will be seen that in no other way can money be so advantageously expended, with the view to future production and cheap supply, as in great works of irrigation and internal navigation.

We are very often apt to suppose that the delay of a few years does not signify very much in the completion of a work. Such at least is our practice; it has always seemed to me one of the most serious points connected with our administration, that when we resolve, we do not recognise the enormous importance of getting it as speedily as possible.

IRRIGATION AND LAND REVENUE.

EVIDENCE TO SHOW THE LARGE AREA OF CULTURABLE LANDS NOT CULTIVATED (FOR WANT OF WATER AND CHEAP TRANSIT).

MADRAS.—MR. R. A. DALYELL'S EVIDENCE BEFORE THE PARLIAMENTARY COMMITTEE, 1871.

How much more culturable land within these districts (of Madras) is still untaken up can be obtained from the returns of the Board of Revenue, but I believe I should be within the mark if I placed it at 25 *per cent. on the present area of cultivation* (17,000,000 acres).—(March, 1871. Minutes of Evidence, vol. i p. 57.)

PUNJAUB.—SIR ROBERT MONTGOMERY'S EVIDENCE.

I should say that the whole area of the Punjaub, including the territory of the dependent chiefs, amounts to 200,000 square miles; of those 200,000 square miles, about 100,000 belong to the British Government; the exact figure is 95,768. Of those 95,000 odd square miles, 31,513, or about a third, is cultivated, *and* 25,000 *culturable, so that there is a very large margin for future cultivation—almost as much as there is now cultivated.* In fact, if canals could be brought into the centre of those Doabs, particularly two of them, the whole would be a mass of cultivation; and, therefore, there is a hope of the future revenue being increased there.—(March, 1871. Vol. i. p. 44.)

FIFTEEN THOUSAND SQUARE MILES NOT TILLED IN THE CENTRAL PROVINCES.

(Evidence of Mr. Commissioner Morris.)

There are Government waste lands, to the amount of about 15,000 square miles, in the Central Provinces.

It would be proper for the Government to undertake works of irrigation; but I do not think that in the Central Provinces anything but a large and comprehensive work would do much good. There is a work proposed, but the last estimate

brings it up to above a million. It is a reservoir formed about 20 miles above Nagpore, and the canal will extend through the valleys of the Wurdah and the Weigunga. In this large scheme of ours, we propose to repay the interest on the capital which the Government would advance, by an enhanced cess, under the name of a water-rate, which would vary with the different crops grown on the land which was irrigated. It will have a good influence also on the inferior portions of the soil. Very often it would not do so much for the rich portions of the soil as for the inferior; much of the inferior would, with water applied to it, give a good crop, which now gives next to nothing. I think the produce might be trebled if the land were properly manured, and so on. In the case of a road, he would have the benefit, whether he wished it or not; but in the case of irrigation, he would not get any benefit from the water unless he took it.—(March, 1871.)

CENTRAL PROVINCES. OFFICIAL REPORT, 1872.

The land revenue of the Central Provinces amounts to over half a million. Out of an area of 36,000,000 acres, a little less than a third is cultivated, and about another third is cultivable.

30,000 SQUARE MILES NOT TILLED IN BRITISH BURMAH.

(Sir A. P. Phayre's Evidence.)

There are only about 3,000 square miles that are under cultivation. The whole is about 94,000 square miles. The rest of the land is composed of jungle, forest-trees, grass; and about one-half of the mountains is covered with forests.

The quantity of land that remains in Burmah that could be tilled, that is not now liable to assessment, is probably 30,000 to 40,000 square miles.

Irrigation is very little required in British Burmah; the object of the public works, in fact, as regards agriculture, is to keep out floods by embankments. The rain is very large, and the rivers rise very high. Irrigation is only known in a few corners of the provinces. There is a great want of communication.—(Select Committee, April, 1871, vol. i. pp. 78, 79.)

OUDE.

(Sir Charles Wingfield's Evidence.)

Oude is about the richest and most densely peopled part of India—466 people to the square mile.

54·60 per cent. of the land is cultivated; cultivable, but not

under cultivation, 21·51; barren, 7·82; tanks, 6·54. Oude is abundantly supplied with reservoirs.—(April, 1871.)

(Sir B. Frere's Evidence.)

Extension of irrigation is the great source from which extension of land revenue may be expected.

There is no doubt that agriculture is capable of quite as much improvement as has been shown possible in our own country during the last fifty years, provided experiments are conducted with judgment by practical men. No system of mineral manuring has been attempted in India. There is a great waste of manure in fuel owing to the want of firewood in the country; the forests have been recklessly cut down. They have been of late years very much systematized and extended, but they are still far short of what is necessary and desirable.—(Evidence of Sir H B. Frere before the Select Committee, March, 1871)

WET LANDS YIELD THREE TIMES MORE REVENUE THAN DRY LANDS.

MADRAS PRESIDENCY—DRY LANDS, AVERAGE ASSESSMENT PER ACRE RS. 1-11-3.

Districts.	Acres	Assessment.	Per Acre.
		Rs.	*Rs. a. p.*
Ganjam	104,512	1,35,429	1 4 9
Vizagapatam	46,546	52,480	1 2 1
Godavery	229,787	4,93,117	2 2 4
Kistna	1,299,511	20,15,533	1 8 9
Nellore	538,223	7,23,611	1 5 6
Cuddapah	1,064,693	8,01,949	0 12 1
Bellary	1,981,884	13,55,835	0 10 11
Kurnool	1,109,644	10,93,891	0 15 9
Madras	160,587	2,52,778	1 9 2
North Arcot	358,838	5,15,843	1 6 9
South Arcot	795,989	13,97,731	1 12 1
Tanjore	217,070	2,72,157	1 4 1
Trichinopoly	679,757	6,78,288	0 15 11
Madura	575,650	7,81,628	1 5 9
Tinnevelly	818,612	6,96,838	0 13 8
Coimbatore	1,826,877	16,87,674	0 14 9
Salem	978,934	12,48,024	1 4 5
Malabar	374,648	5,91,750	1 9 5
Total	13,161,761	147,94,556	1 1 11

WET LANDS, AVERAGE PER ACRE RS. 4-14-3.

Districts.	Acres	Assessment	Per Acre.
		Rs.	*Rs. a. p.*
Ganjam	170,617	4,91,827	2 14 1
Vizagapatam	22,889	1,20,795	5 3 9
Godavery	203,216	5,89,870	2 11 5
Kistna	147,812	8,15,978	5 8 8
Nellore	167,757	8,14,270	4 13 10
Cuddapah	127,396	8,82,830	6 14 10
Bellary	154,537	6,15,994	3 15 9
Kurnool	25,603	1,79,164	6 15 11
Madras	234,338	9,27,966	3 15 9
North Arcot	193,323	11,27,229	5 13 4
South Arcot	261,823	14,09,534	5 6 2
Tanjore	674,155	33,39,185	4 15 3
Trichinopoly	119,334	5,12,050	4 4 7
Madura	125,669	5,43,088	4 5 2
Tinnevelly	159,726	16,52,848	3 7 8
Coimbatore	80,186	6,13,924	7 10 6
Salem	77,626	4,81,054	6 3 2
Malabar	380,425	11,59,626	3 0 10
Total	3,326,432	162,77,232	4 14 3

DETAILS OF WET AND DRY ASSESSMENT—EXAMPLE OF SALEM DISTRICT.

Talook.	Dry.	Wet
	Rs. a. p.	*Rs. a. p.*
Dharampoory	0 14 6	4 7 2
Ahtivoe	1 3 2	6 15 10
Salem	1 10 1	5 3 3
Namkeel	1 2 4	7 10 3
Tuichengode	1 6 0	5 12 1
Uttugherre	0 12 0	3 12 11

NETT RESULT IN MADRAS PRESIDENCY.

Dry cultivation, 13 million acres, produced	£1,479,455
Wet „ (only) 3 „ „ „	1,627,723
	£3,107,178

The land assessment in India is increasing every year: in 1872 it was twenty millions sterling. The cost of collection is 10 per cent.

EVIDENCE REGARDING RATE OF LAND ASSESSMENT IN INDIA, TAKEN BEFORE THE PARLIAMENTARY SELECT COMMITTEE IN 1871-72.

N.-W. PROVINCES—EVIDENCE OF SIR R. MONTGOMERY, K.C.B., G.C.S.I., MEMBER BOARD OF ADMINISTRATION, PUNJAB, ETC.

The proportion the Government now take, instead of being two-thirds, is only one-half. It was found that two-thirds was rather more than they could very easily pay, and the Government decided it would be quite sufficient to take half the assets; they agreed to take only 50 per cent., and 5 per cent. for expenses.

Supposing the nett assets of an estate to be 1,000 rupees, the land revenue will be 500 rupees (£50). Half per cent. is put on for the road fund, which is 5 rupees; half per cent for the school fund, which is 5 rupees; one-eighth per cent. for the postal department, which is 1 rupee 4 annas; and three seven-eights for municipal purposes, police, town improvements: altogether, 550 rupees are taken, and that is taken from the landholder; but nothing beyond that.—(Vol. ii., pars. 1,611, 29.)

PUNJAUB—SIR R. MONTGOMERY'S EVIDENCE.

The Government, in the first instance, took two-thirds of the nett profits after all expenses were deducted, but in a late settlement they took only half. In this new settlement, in addition to the half nett return, the proprietors have been called upon to pay 1 per cent. for roads, and 1 per cent. for education; that is an arrangement of the settlement.—(Vol. ii., par. 770, 803.)

OUDE — SIR C. J. WINGFIELD'S EVIDENCE (LATE COMMISSIONER OF OUDE).

The settlement is fixed on the principle of 50 per cent. of the rental, for thirty years, just the same as in the North-West Provinces.—(Vol. ii., pars. 1,902-9.)

MADRAS—MR. R. A. DALYELL'S EVIDENCE (SECRETARY OF BOARD OF REVENUE).

The nett produce is ascertained as nearly as possible, and half that is taken to be the Government share of the produce; that half-share is then commuted into money on the average price of a series of years.—(Par. 1,029.)

Old Assessments.—When the Government found the assessments were too high, and that good land was allowed to go out

of cultivation, temporary arrangements were made, reducing the rates.—(Par. 1,044.)

In each village a certain portion of the cultivable land which was waste at the time of survey has been surveyed and assessed. The increase in the last few years shows every year a large quantity of waste land, or land that is capable of being cultivated, is taken up, and we are obtaining a large increase of revenue in that way.—(Pars. 1,038, 1,040, 1,041, 1,042.)

CENTRAL PROVINCES—MR. J. H. MORRIS'S EVIDENCE (CHIEF COMMISSIONER).

The principle that we go on is that the Government is entitled to half the nett profit, so that the object of the settlement officer is to find out what is the rent of a certain tract of country, and then, having ascertained that, he takes half of the nett profits.

BURMAH—SIR A. P. PHAYRE'S EVIDENCE (CHIEF COMMISSIONER).

As soon as the British Government came in, in consequence of its being made easier to the cultivator by a money payment (instead of in kind), the proportion taken by the Government was doubled. Under the native government it was 10 per cent., but the individual had to convey the proceeds to a government granary or to some other place. That was no longer required of him, and then 20 per cent. of the gross proceeds was assumed, and that was commuted for a money payment of the supposed value of the 20 per cent.

BOMBAY—SIR H. B. E. FRERE'S EVIDENCE (LATE GOVERNOR OF BOMBAY).

The proportion varies from a very light quit rent to a very severe rack rent. An extra cess at the rate of one anna in the rupee—that is, one-sixteenth of the assessment—is imposed for roads and schools. The schools were to be of two kinds—schools for primary instruction, and schools in which mechanical art would also be taught, so as to improve the mechanical arts of the country. The wet land in a revenue sense is generally rice land, which is assessed very much higher than any other kind of land. In Government villages I think at present about 10 rupees (£1) per acre would probably be the highest assessment on one acre.

ESTIMATE OF LAND REVENUE DUE TO CANAL IRRIGATION.

TOTAL ACRES WATERED BY CANALS.

By the principal works of irrigation in operation in India, the total acres watered by each canal is as follows:—

Works.	Acres.
Godavery	225,000
Kistna	144,600
Pennair	875,100
Cauvery	
Ganges	766,614
Eastern Jumna	212,714
Rohilcund, Dh.	68,652
Baree Doab	279,210
Western Jumna	462,707
Sutlej I. Canals	451,446

or including minor works of irrigation, say four million acres are irrigated by canals in operation. It is a noteworthy fact that none even of the above works are quite complete. According to the Government "forecast," dated July, 1873, the Godavery works will be completed in 1877, the other works a year later. The remodelling of the Ganges, the Baree Doab, and other canals, has been commenced with the view of correcting the defects in original designs, so that these works in Northern India are expected by Government to be completed in 1878.

STATE OUTLAY ON CANALS.

According to the finance and revenue accounts of India presented to Parliament in 1873, the total outlay on the above principal works in operation amounts to nearly six millions sterling. The Under-Secretary of State for India, in his budget speech in the House of Commons, in 1873, stated that the total outlay on irrigation works, and including works under construction, and not quite in operation, was eight millions. Assuming eight instead of six millions to be the correct figure, it may be stated that State irrigation works in India which thus water annually four million acres have cost eight millions sterling, or £2 per acre irrigated—though the actual cost as shown in these pages in detail is much less.

VALUE OF PRODUCE PER ACRE.

A land-revenue settlement officer in the North-West Provinces, estimated the gross value of the principal crops per acre as follows:—

Wheat, per acre . .	£3	14	0
Pulse	2	4	0
Barley . .	1	12	0
Jowar	1	10	0
Sugar-cane (annual) .	7	16	0

Of the crops irrigated by canals in the North, wheat forms the principal crop, next in value is the sugar-cane, which is an annual crop. In South India, the value of an acre of rice in ordinary times is £2 per acre, which during famine periods rises to £5 and even £7.

If we calculate the gross average value of produce per acre irrigated by canals, including both the hot and cold weather crops per annum, at £3 per acre, we shall be quite correct in our estimate.

GOVERNMENT SHARE OF PRODUCE.

In India the Government has set up the grand theory that all the land belongs to the State, and therefore a certain portion of the produce must be taken by Government. In a question put by the Chairman of the Parliamentary Select Committee on East India Finance, in 1872, he stated, on evidence given before that committee, that the Government took one-sixth of the produce. Some contend it is in practice much more,—even half the value of produce. But we shall take the proportion stated by the chairman (who acted more like a Government advocate than an independent member) as quite correct.

INCREASE IN LAND REVENUE BY IRRIGATION.

Taking £3 per acre as the value of gross produce from canal irrigated lands per annum, and Government share of land assessment one-sixth the value of produce on four million acres watered by State canals, the amount will be two millions sterling per annum land-assessment which Government would not derive but for the canals. Some allowance may perhaps be made for lands watered by wells before the introduction of canals. But, as a matter of fact, the cost of keeping bullocks to draw the water from wells, even only 20 feet deep, is so

heavy, that if there be any wells on lands where canals are introduced the wells are thrown out of use, because the canal water flows to the fields by natural gravity; and in some exceptional cases, where the circumstances are just the reverse, the cost of drawing water from canals only a few feet deep does not come to half as much as drawing water from wells. Therefore all credit in increase of land-assessment from canal irrigated lands may be taken as due to irrigation. The Government of India (Review of Canal Reports, February, 1869) assumes 8*s.* per acre increase in land revenue due to canal irrigation; at that figure the total amount for four million acres watered by canals in India will be £1,600,000. This increase in land revenue is called indirect revenue from canals; but for all practical purposes it is as direct as the canal water rates revenue.

THE GAIN FROM WATER RATES.

In North India the canal water rates ranges from 2*s.* 6*d.* to 4*s.* per acre irrigated, according to the crop grown; and the total amount, as shown in finance and revenue accounts for 1872, amounted to £471,580. But this does not include the Madras Presidency, where the water rate and land assessment is mixed up in one item, and does not appear in canal accounts.

In Southern India the water rate is double that in the North; it is 8*s.* per acre. To show that it is so, we quote the following lines from the notification issued by the Revenue Settlement Office, dated Kisna, Guntoor, November 22, 1872, explaining the principles on which the new land settlement in the Madras Presidency has been made. It says, "all the delta lands irrigated from the anicut channels have been classified and assessed as *dry* lands, and will pay a water rate of four rupees per crop per acre, in *addition* to the land assessment."

From Progress Report of India for 1872, presented to Parliament, it appears that more than one million acres are watered by the English works of irrigation in the Madras Presidency. Therefore at 8*s.* per acre the amount of water rates will be—

For Southern India . .	£400,000
Add for North India . .	471,000,

so the total amount of canal water rates for India will be £871,000.

MAINTENANCE CHARGE.

From the water rates must be deducted the annual charge for maintaining the works in repair. The following figures are taken from the B. B. Finance Accounts, 1872, showing the expenditure *ordinary* on the maintenance of each principal work of irrigation in operation.

Works.	Maintenance
Ganges Canal	£3,333
Eastern Jumna	1,233
Doon	677
Rohilcund	10,824
Minor works	2,417
Punjab canals	8,816
Madras canals	9,818

adding for establishment, which is not included in ordinary expenditure, 30 per cent., the total will be £26,000. Deducting that from the gross amount of water rates, the net amount of water rates will be £411,000.

THE INTEREST CHARGE.

In ordinary times the cash balances in Indian treasuries amount to more than thirteen millions sterling. From the cash balances alone in one year, when tried, it has been found practicable to construct works of irrigation, without any aid from loans. But let us assume loans were expressly taken for irrigation works in operation, not at 4 or 4½ per cent., but 5 per cent. Yet, at 5 per cent., the interest charge on eight millions outlay will be less than the item of one canal revenue alone—the net amount of water rates.

THE GAIN TO THE GOVERNMENT

From eight millions outlay on the principal works of irrigation in operation is, that not only the interest charge is quite covered, but a surplus in water rates, and a clear nett gain in increase of land revenue due to irrigation to the amount of 1½ million. What works in the world, which belong to the State, pay so handsomely, in the aggregate, as do the irrigation State works in India?

WHAT IS THE GAIN TO THE PEOPLE

Is seen at a glance. An outlay of eight millions irrigates four million acres; and as the value of produce per irrigated

acre is £3 average, or say even £2, the total value of food grains and other agricultural produce due to canal irrigation at the lowest figure is eight millions sterling. In other words, by State irrigation works agricultural produce, equal in value to the total capital sunk in works, is produced every year. Can any one deny that increase in the industry and wealth of the country by State irrigation works?

CANALS ALSO SERVE FOR NAVIGATION.

There is another vast gain to the people—that of cheap transit. Irrigation canals in India have been and can be made, at a trifling expense, navigable, so that native boats and small steamers of about 250 tons run over them, even in dry seasons, if the canal is kept full by storing water, which in its turn does a double duty—preventing also floods in the wet seasons. No means of transit exist of taking bulky agricultural produce so cheap as on water. Taking roughly, the weight of produce per acre half a ton, and the saving in carriage a half-penny per ton per mile, the result from cheap transit by navigable canals to the people, for the produce of four million acres will be every year a gain greater in amount than the water rates derived by Government, or the amount of interest on capital invested by the State on canals.

M.P.S AND IRRIGATION WORKS.

One or two members of the late Parliamentary Select Committee on Indian Finance from their questions seemed to think that irrigation works in India should be undertaken by Government, provided the estimated amount of water rates alone from new works was more than the interest-charge on capital outlay. Well, let us for one moment forget all the advantages from irrigation works, in increase of agricultural production, in increase of land revenue, the gain to the people in cheap transit, and all that. Let us lay aside the fact that, owing to want of canals, though famines have carried away millions of human beings and destroyed agricultural property to the extent of millions sterling—that it is not the duty of the State to preserve their subjects from starvation and unnatural death—that those who died by the million so recently in 1866, in Orissa, within thirty hours' steam of Calcutta, did not contribute a shilling directly or indirectly to the Government, or that no agricultural property was destroyed by the Bengal

famine in 1874, and no expense was entailed on Government thereby, let us even assume for a moment that no loss there has been, or will be incurred in future, from famines—that it is not the duty of a civilised and Christian government to save its subjects from the horrors of famines—that it is the first duty of the English administrators in India, before constructing such works as irrigation canals, to prove that the outlay will bring in returns in the shape of water-rates alone, so as to cover entirely the amount of interest of the money borrowed, and that on such conditions only canals should be constructed from borrowed money, and no other conditions ought to be recognised. Yet if anything can be proved of any reproductive public works in India, this will be from actual results that canals will prove financially successful, provided works are well designed, and constructed substantially, and finished, with all the branches, in as short a time as possible. It is only in famine times that real energy is shown, and 20,000 or 30,000 persons employed on such works, as happened on the Soane Canal during the famine in Bengal in 1874. When, if that canal had existed, and in complete operation, the very name of famine in that year would not have been heard in Bengal, and six millions spent in feeding people in 1874—or a million more than the total estimated cost of Soane works under construction—would have been saved to the country.

The principle still acted upon by Government, as seen in the latest financial accounts of India, is to fix and spread over a series of years the construction of irrigation works: it matters not if the works are small or large, simple or difficult, the only aim being that the total irrigation works' expenditure per annum should be half of outlay on State military railways. The character of the work itself, the necessity of finishing it as soon as practicable,—or in what time it can be so finished as to give quick returns on the outlay,—all such considerations seem to play no part, nor is there any provision made in case of the cash balances proving insufficient for a separate irrigation loan, to be devoted, under any circumstances, solely to that object and no other. The sooner that is done, and ample provision made for such works, the better.

THE LESSON WE OUGHT TO LEARN.

The result of irrigation works in operation teaches us this lesson, that notwithstanding bad mistakes in some cases in

designing works made by engineers from want of experience—that from want of policy works have been constructed from the surplus annual revenue, one year stopped from want of funds, another year an inadequate amount doled out—again, owing to financial deficits of the year, all the labourers collected on the works dismissed, all the time the European staff, the most expensive, remaining the same. Then again, in another year, works resumed, so much so,—that the most, or one of the most, profitable works in India, which was suggested in 1800, commenced in 1847, designed and constructed by that noble-minded Englishman, Sir Arthur Cotton, whose name will always be gratefully remembered by India's sons as their greatest benefactor,—even such a most successful work is *not* complete to this day, to our shame and humiliation, and only irrigates half a million acres instead of one million, which will be when the work is completed in 1878.

It is also a fact, that important parts of some works have been so constructed, on account of the small grant of the year, as to require heavy repairs every year, thus taking away all the profits, and necessitating the closure of the canal at the most critical time when water for the crops was most wanted, and, on account of the incomplete state of the work, shaking the confidence of the cultivators in the constant supply of canal water. Works thus constructed, in the most unbusiness-like and most uneconomical manner, when they have been tolerably completed, have proved financially successful, as shown in detail in these pages. Let us not forget how these works have been constructed, and the results of such incomplete works. An outlay on irrigation works of eight millions brings in a nett water-rate, say half a million, increases land revenue by one and a half million, produces agricultural crops worth eight millions every year, besides the gain in cheap transit, estimated at some millions. In India culturable land to the extent of millions of acres remain uncultivated, chiefly because, with no rain for eight months of the year, speaking generally, no crops can be grown with profit without artificial irrigation. The sun is powerful enough to develope growth in vegetation, but, with the sun, water is absolutely necessary in almost all parts of India.

DISCUSSIONS BEFORE THE PARLIAMENTARY SELECT COMMITTEE

'ROSS-EXAMINATION OF GEN. R. STRATCHEY, R.E.; S.P.W.D.

Chairman: Do we rightly understand you that you claim ı the benefit of the irrigation system a larger profit than that ııch is represented by the water-rate, because the owner and cupier of the land get more benefit from the irrigation than ıat is represented by the water-rent?—Yes. The systems ıder which charges are made for irrigation in different parts India differ greatly. In the upper provinces of India, where ›u have a cultivator separate from the landlord, and the ›vernment over the two, the position is peculiar; and the last ›p that the Government of India has taken in the matter, as gards Upper India, is practically to adopt a suggestion made ' me, in the law just passed for the Punjaub, under which e water-rate for the future will be reckoned in this way: st of all there is what is called the cultivators' or occupiers' te; and next there will be the landlords' rate, which for the ture will take the place of that increase of land revenue which, › to the present time, has represented the Government share the additional profit due to irrigation received through the ıdlord.

Got through the means of the revenue?—Yes, but it has en generally accepted that in reality this income is not of e nature of what is commonly called land revenue, but is in ality profit due to irrigation; and consequently, for the ture, instead of being taken as land revenue, it is to be taken landlords' water-rate.

Sir C. Wingfield: Is it not the case that when a settlement īcer goes to assess a village, he finds a certain proportion of e land irrigated; he does not inquire whether this land has en irrigated by a canal, or by a well sunk at the expense of e proprietor, but he says, "This being irrigated land, it yields certain rental." Therefore it follows that, if the irrigation d been provided by the natives before you made your canal, › part of the increased revenue on irrigated land is derived ›m your canal; that is to say, that your canal has not con- buted to any increase of the revenue, because the sources isted before in the irrigation supplied by the people them-

selves ?—Supposing that the rental of the land irrigated from wells was as high actually as that of the land after the canal irrigation had been introduced.

But have you not also heard it often said that well water is far better for the land than canal water, because canal water holds in solution a considerable deposit of granite washings ?—Yes; but as a fact, wherever the canal is taken, it drives all the wells out

Where the land is abundantly irrigated and you make a canal, you cannot claim for any acre that was irrigated before your canal was made, that you have added to the Government revenue on that land ?—If there is no increase of revenue in consequence of irrigation, no one in his senses, of course, would think of claiming any increase on account of it.

How are those receipts (from the Madras Delta works) derived, do you know? are they simply from the sale of water ?—My calculation was based entirely on the profit of irrigation. The approximate returns on the Godavery works at the present time is about 22 per cent. on the capital. For Tanjore I make out that the return may be about 20 or 25 per cent.

Merely the water-rate? are you sure the revenue rate has nothing to do with it ?—No, nothing but the irrigation profits; the Madras rates, you know, are very high; the revenue rate upon dry land is about 2½ rupees, or less, per acre, and the revenue rate upon irrigated land is about 7; therefore it is very high, you see—equal to a water-rate of 4½ to 5 rupees per acre.

Mr. Fawcett: If that instruction of yours were carried out, you would credit these irrigation works with all increase of revenue from whatever source it arose; for instance, if the great depreciation in the value of money continues, the price of agricultural produce would proportionately rise, and, if it rises, the land revenue would proportionately be able to be raised; but you would credit all that increase in the land revenue to the irrigation works ?—That portion of it which is due to irrigation I should.

You have to ascertain what is due to irrigation ?—The facts, as they can be ascertained, should be accepted. Where the land revenue is fixed for a term of years, the canal share of that revenue would be the portion which at the commencement of the term was charged on account of the irrigation, and no addition to the canal share would be justified

during the term, or until some actual revision of the land revenue had been made, and then only on the same principle

Mr. Cave I suppose a great portion of the land which is brought under irrigation by the canals would be absolutely unculturable without irrigation?—Well, it might be, but not as a rule.

What portion is brought into cultivation by the irrigation works?—I think it is impossible to generalise upon that. In some parts of the country, for instance in Scinde, without artificial irrigation cultivation is impossible, because there is no rain, but in other parts of India the irrigation merely supplements the natural fall of rain

In those places where it is not possible, there is no land revenue at all, before the irrigation?—No; you may say that the land revenue depends entirely upon the existence of the irrigation, which is the case in Scinde.

In such cases the diminution in the value of money would have no effect whatever upon the revenue of land that is not cultivated at all?—Of course it would not, because there would be none.—(Extracts, June 1872.)

COST OF RAISING WATER FROM WELLS.

The great objection to the well-system is its cost (not so much in the original construction as in working it with the present ineffective mode of raising the water). The bullocks employed seldom last more than three years, and are worn out. The expense of well-irrigation is estimated at from 40 rupees to 60 rupees per acre per annum.

Few greater benefits could be conferred upon the country than the introduction of an improved machine for lifting water Such a machine must be cheap, simple, capable of being easily repaired by a village artisan, and of raising with a pair of bullocks working on the level twice as much water as a pair working on an inclined plane can raise with the bucket. Several machines for lifting water have, we believe, been recently invented, and we think Government should ascertain if any of them answer these conditions, and should then take measures for their general introduction. We spend money enough upon inventions for the destruction of human life, and might well spare a little for inventions which tend to preserve it.—(*Times of India*, February, 1869.)

LORD LAWRENCE'S CROSS-EXAMINATION BY MR. FAWCETT, PARLIAMENTARY SELECT COMMITTEE, 1873.

(Questions omitted for want of space.)

I have no doubt in my own mind that the people would take the water; it takes time for them to take the water as they ought to do: they see that their crops are doubled, trebled, and perhaps quadrupled, and that instead of being only able to grow inferior crops, they can grow very valuable crops; in that way the advantages of irrigation become apparent to them, and then, in course of time, they take the water very extensively. I am convinced in my own mind, not from theory, but from experience, that irrigation from canals would pay, and pay largely, where it is conducted in a proper economical way.

I do not think that any of the irrigation works that have been undertaken by the Government have turned out to be failures. At this moment the only work of that kind is the one in Madras, which was undertaken by a company, and for some reason or other hitherto it seems to have been a failure. I do not understand exactly why or wherefore, but so apparently it is; but I should hope even that that work would hereafter be so improved that it would pay.

I think that there is one element in the question, which apparently you have not taken into consideration, and that is the great saving of revenue which has been effected by the existence of the Ganges Canal. I would say in a broad and general way, that the money which you saved in the year 1861-62 in the shape of land revenue, and in the shape of saving the property of the people, was far more, on the most moderate calculation, than all the accumulated interest which we lost until the canal paid say 5 per cent. on its actual outlay.

The actual authority which I quoted as to the saving of land revenue, and the saving of property in the drought of 1861, was Colonel Baird Smith, an engineer officer of great ability and reputation, who is now dead, who was sent up by Lord Canning immediately after the famine, when the effects of the famine could be seen, and he got together all the data of the famines which had occurred in previous years; and I have been present in India, living in some of the districts where the famine in 1838 and the famine in 1834 occurred, and I have no doubt myself that the estimates made by Colonel Baird Smith were very likely correct, or at any rate were very near the truth.

But taking his data, and assuming that one-fourth of it, or one-sixth of it, or one-eighth of it was a real saving, instead of what he put down, I would say that that value was more than equal to all the loss of interest during the time that the Ganges Canal was under construction.

There is no doubt that on some of these lands some cultivation would have gone on under wells, but that is very scanty compared with what you get from canals; and where the land is distant from the water, the wells become dry very often, or fail to a very great extent, when you want the water most to complete the crops, to give them their last two or three waterings.

I should say that what Colonel Baird Smith intended to convey was, that in those lands on which in 1837 the crops more or less entirely failed, there was an abundant harvest in 1861, consequent upon the irrigation from the canal

I travelled through those districts in 1837; I saw the utter barrenness of the land; the whole country was waste, there was not a green leaf of any kind or description in many of the districts. I saw large tracts of land under canal irrigation in other districts in those very years of which we have been speaking, and there it was one sea of corn and barley.

My view is, and I have always said, that India, as a whole, is an exceedingly poor country at present, and one of the great objects which I have in view is, as it were, to relieve that poverty by a permanent settlement and in other ways.—(Extracts from Evidence, July 1, 1873, pp. 442-3.)

NOTE ON MADRAS IRRIGATION COMPANY'S WORKS.

This is the only irrigation work in India carried out by the agency of a company.

The main canal extends from Kurnool to Cuddapah, a distance of a hundred and eighty-nine miles, constructed for navigation as well as irrigation; the maximum depth of water for which the canal is adapted is 6 ft., but hitherto it has carried no more than 4 ft. Out of a length of 382 miles of distribution channels, 313 miles, commanding an area of 156,570 acres, have been executed.

The total area irrigated in 1871 was only 1,478 acres, while in 1873 the area irrigated had increased to 9,505 acres, and the revenue to upwards of £5,000. The upper section of the canal, especially within the first thirty-five miles, has un-

gated a considerable portion of the culturable area, while more in the lower section are apparently as yet only feeling their way.

High Water-rates.—The present rates for water, charged by the company, are 6 rupees (12*s.*) per acre for regular irrigation of one crop, and 1 rupee for each flooding; and these prices are irrespective of the nature or value of the crop grown.

The canal runs only for six months of the year; water only being allowed to be taken from the Toombuddra, for the supply of the canal, between the 1st of June and the 1st of January; so long as this is the case, there will be hesitation on the part of the cultivators. They are chary of effecting a change in the mode of husbandry until they have become thoroughly assured, and feel that they can safely rely on the source whence the irrigation necessary for wet crops is to be obtained.

The main source from which the company's canal is fed is the river Toombuddra; there are four others, but at present they are only useful in sometimes affording a small supply during the time when the Toombuddra waters are obliged to be shut off. The canal in the original project was intended to be continued down the valley of the Pennair to near Nellore, and thence to meet the East Coast Canal from Madras.

The advisability of constructing a reservoir at Masoor, to make the canal perennial, on the Choardy, with the view of supplying water, and the extension of the canal from Cuddapah to a junction with the East Coast Canal, in the interests of navigation as well as of irrigation, has been suggested in the late report of the Inspector-General of Irrigation.—(*Engineering*, May, 1874.)

THE QUESTION OF WATER-RATES REQUIRES SETTLEMENT.

IMPORTANCE OF FIXED WATER-RATES.

(By Col. B. Smith, R.E.)

However important it be to proceed with the execution of works of irrigation, it has now become quite as important to great social and public interests that the general principles on which the irrigation department is conducted should be investigated, and, if found susceptible of improvements, should be

improved. Our present irrigation system is not, correctly speaking, a creation, but only a restoration and extension of one that had existed in some considerable vigour for three or four centuries of the Mahomedan period.

To fix the public demand on the water, first for a period, so as to make sure of a light, equable, and fair assessment, and then in perpetuity, with power of redemption, will stimulate growth in irrigation, and, with it, growth in most of the elements of material prosperity. The vast water-power, too, which the falls of the canal make available, might be turned to account for working machines. Such use, once shown, would in all probability soon tempt private enterprise into the same field.

In the hope that it may be useful in indicating the still unused resources of the canal in these ways, I place a memorandum on the subject, from which it will be seen that somewhere about 40,000 horse-power waits employment.—(Extract from Famine Report.)

DISCRIMINATING RATES. RESOLUTION, GOVERNMENT OF INDIA, 1864.

The system of discriminating rates is, in the opinion of the Governor-General in council, altogether a mistake. There should be but one rate for all crops except sugar-cane, and this rate his Excellency in council thinks might, for the present, be 2·4 rupees per acre: for sugar-cane the rate might be fixed at 5 rupees, being somewhat more than double the former This would almost amount to saying that there should be one rate for all crops which require one season to mature, and double for that crop which requires two seasons. The above rates refer to *tor* irrigation, that is, by natural flow; for *dal* irrigation, or for water raised artificially, the rate will be reduced as at present one-third, that is, to 1·8 rupees and 3·4 rupees per acre.

OPINION OF SIR ROBERT NAPIER, K C.B., MEMBER OF THE COUNCIL OF THE GOVERNOR-GENERAL.

The complicated system of our early canal administration, which placed a very small rate on the water, and varied that rate with the varieties of crops, whilst the real price of the water was taken by the collector of revenues in increase of assessment, opened the way to the greatest amount of fraud, the greatest expense in measurements of areas irrigated, and the greatest distress and annoyance to the people. If a uniform and sufficient price were put on the water, without any reference to the land revenue, it would greatly simplify matters. Such a rate might be based on a fair remunerative per-centage on the outlay, the land being freed from any liability to further charges on account of improved cultivation.—(Minute, Jan. 3, 1864. P. R. p. 11.)

COL. STRATCHEY ON WATER-RATES FOR NEW CANALS.

The water-rate would be arrived at by a comparison of the relative value of thoroughly irrigated land, and of dry land of equal fertility and convenience of position.

The water-rate should be reckoned by reference to a maximum rate, which would represent the full value of irrigation of a complete sort For one-crop land, this might amount to 4 rupees per acre for tank irrigation and 5 rupees for river navigation, and, perhaps, double those rates for two-crop land. These figures have been named as indicating what I gather might be reasonable. Possibly, the higher rate should be charged for tanks fed from rivers, the supply being more certain. The water-rates fixed by the settlement would allow for the annual fluctuations of the rainfall as indicated by past experience, and no remissions would be claimable on account of such variations. The maximum water-rate should, as far as possible, be made uniform for the same talook or district, and an absolute maximum rate might probably be prescribed —(Feb , 1868)

DUKE OF ARGYLL ON WATER-RATES.

A preferable arrangement to that which is contemplated by the bill would perhaps be one to which allusion was made by your Government, according to which cultivators, instead of paying in proportion to the quantity of water taken by them, that is, more in a dry year and less in a wet one, would be assessed at an equal rate per acre of their irrigable land in all years By this means, both the cultivators and Government would gain in some years, and lose in others, but the gains and losses of each party would, on an average, balance each other. It would, however, no doubt rest with Government to fix the rate, and whatever rate, according to the data available for calculation, seemed necessary to yield the desired per-centage on the cost of the canal, that rate might be fixed accordingly. This course would probably be less unpopular with the rate-payers than that of making them pay more in certain years, in order to make up for the deficiency of their payments in previous years —(Extract from dispatch to Lord Mayo, Governor-General of India in council, October, 1869, P R., 389, p. 99.)

ABSURD PROPOSAL OF INDIAN GOVERNMENT CONDEMNED BY THE DUKE OF ARGYLL.

The bill which declares that "if at any time, not less than five years after the commencement of irrigation from any canal, the average nett revenue in the three next preceding years realised by the Government from the use of the water thereof, and including all sources of income dependent on such canal, and deducting all charges for maintenance and management and working, properly debitable to the revenue account of the same, shall not amount to a sum equal to seven per cent. on the capital expended on the said canal, the local

canal, but not paying any water-rate therefor, such a yearly rate or rates as shall, when added to the nett yearly estimated income, reckoned as aforesaid, produce a total amount as nearly as may be, equal to seven per cent. on the capital aforesaid."

I will now explain in what my objections to this section consist.

The object of the provision in question is to enable Government to secure itself against pecuniary loss in the event of a canal proving a financial failure Such failure might ensue from three causes. A canal might not be able to supply, for irrigational purposes, the expected quantity of water, or, the expected quantity being available, cultivators might decline to avail themselves to the expected extent, or excessive costliness of construction might, in order to render a canal remunerative, necessitate the imposition of higher rates than cultivators could afford or would voluntarily pay. In the first case, under the proposed enactment, the loss consequent on Government having engaged in an unsuccessful speculation would fall, not upon itself, but upon the cultivators, whom it had disappointed. In the second, cultivators would be forced to pay for water for which they had no use, or, at any rate, were not disposed to use, possibly, no doubt, from imperfect appreciation of the value of irrigation, but quite possibly also from a perfectly intelligible desire to have part of their land under dry crops, instead of all under wet With regard to the third, none can require less than your Government to be reminded how prone to become excessive guaranteed expenditure always is, and under the provisions of the bill all expenditure on Government canals would be guaranteed.

It will therefore be satisfactory to me to learn that the section to which exception has been taken can be so far modified as to obviate any objections.—(Dispatch to Lord Mayo in council, October, 1869. P. R. 389, p. 98)

ARBITRARY RULES: ORISSA CANAL.

The revenue superintendent, or his deputies, are to decide whether or not one desiring to obtain water for irrigation has to pay for the cost of construction and maintenance of water-channel, reservoir, &c.

There are certain periods of the year at which the measurement of irrigated lands is taken; but the time fixed suits the convenience of the authorities more than that of the ryots.

The canal patrol, who is chowkeedar on a salary of 5 rupees a month, has to enter in a register the fact of any cultivator making use of canal water for the first time of the current year, in default of which he is liable to be fined or criminally prosecuted. This is as much a lucrative as a responsible post.

The revenue, deputy, and assistant superintendents are vested with powers of a collector and magistrate in disposing of cases connected with the revenue. This facilitates the work a great deal. but it is productive of injustice and hardship.

The rules have been framed so arbitrarily that they are frequently attended with oppression. The rule by which a cultivator is made to

pay the water-rate, even if he does not apply for or make use of canal water, but only for the circumstance of the canal distributaries being carried over his fields, in order to supply water to his brother cultivator, who applies for it, is indeed based on no principle whatever

By cutting channels over fields the ryots are put to the trouble of walking miles and miles with their cattle in order to reach their fields: the irrigation department contemplate bridging these channels at every mile.

It was the last famine which led to the introduction of irrigation in this country, but the rules framed for the purpose have proved so severe that the poor ryots find it hard to comply with them.—(*Indian Economist*, June, 1871.)

COL. FRANCIS'S NEW PLAN OF WATER-RATES.

My inquiries lead me to think that the system of canal management for our new irrigation works adopted has a good deal to do with the present reluctance of the cultivators to make use of the water. A man does not like the trouble of applying to the canal officer at a fixed date for water for a certain area for khureef and rubbee crops respectively, and, besides, it may be said to be practically impossible for individual ryots to irrigate their land, except it happens to be on the immediate boundary of one of the main distribution channels. But if, as will ordinarily be the case, the water has to pass by subsidiary watercourses through the fields held by other cultivators before it can reach the lands of the applicants, he must either get them to join in doing the clearance of the watercourses through their respective fields, or undertake the work himself, which he cannot be expected to do If, on the other hand, certain tracts of land are regularly set apart for irrigation, it will be the interest of the whole body to combine and keep the subsidiary watercourses in order. This plan, too, provides for a more economical use of the water than that of letting it off only to those who may happen to apply for it, as in the latter case we shall have a field here and there irrigated, and the water running between these detached fields subjected to considerable loss by leakage and evaporation.

The people are also deterred by the fear of having eventually to pay very high rates They have heard that it is in contemplation in some cases to levy rates of 25 and 30 rupees (£3) per acre for sugar-cane, and naturally they do not like to incur the expense of preparing land for irrigation, with the prospect of being eventually taxed to this extent. It is high time to abandon the idea of being able to levy any such rates.

My proposal is that certain lands should be allotted for irrigation under our new canals, that a light, fixed rate per acre, to be annually levied, should be imposed on this area, and that the cultivator charged with the water-rate should have the option of using the water allotted to his field, or of disposing of it to another cultivator; that he should thus have a right to the water subject to the condition of not being [illegible] to which it is allotted Such is the

system of management under which old irrigation works have been so successful, and I cannot help thinking that, if we wish our new works to become popular and financially successful, we must abandon the system of canal management now being inaugurated.—(J T Francis, survey and settlement commissioner, N. D. and Scind., 28th November, 1871.)

WATER-RATES PER ACRE YEARLY IN SPAIN.

Canal del Urgel .	19*s*. 3*d*.
Tagus valley . . .	10 per cent. of the produce.
Malaga	19*s*
Lobrigat	5*s*. 6*d*. to 17*s*.
Aragon	4*s*. to £1 7*s*.
Cataluña	12*s*. to 16*s*.
Navarra . . .	12*s*. for four irrigations yearly.
New canals . . .	1*s* 7*d*. to 2*s*. 4*d*. for each watering.
Frequent custom . .	10 per cent. of the produce.

(*Engineering*, March, 1873)

THE QUESTION AS IMPORTANT AS CORN-LAWS IN ENGLAND.

(By T. Login, Esq., C.E., late of the Ganges Canal.)

As each village has, on an average, 200 fields receiving water for different descriptions of crops, with different rates charged on each, the time must soon come, if it be not reached already, when a complete reform must take place in the system of collecting water-rents—a question quite as important to India as the corn-laws were to England. Though no doubt it is proper that water-taxes must be levied, yet it should be done in such a manner that there should be the least possible inconvenience to the public (called by some "oppression" on the part of the canal establishment); and the numerous doors now open to collusion and fraud on the part of the establishment and cultivators should be closed. The time has arrived when a strict inquiry should be made into the subject, and for this purpose a mixed commission should be appointed to investigate this important question. The chairman should be of higher standing in the service than a commissioner of a division; for commissioners and chief engineers would have to give evidence before the commission, as well as collectors and canal officers, down to the tiller of the soil. The commission should therefore be mixed, representing finance, engineering, natural science, medicine, agriculture, and commerce. No officer should sit on the commission immediately connected with irrigation, as he may have preconceived ideas on the subjects; but

all classes, from the rajah to the ryot, should be called on to give evidence. This commission would have an arduous duty to perform, for the subjects to be investigated are multifarious and of great variety; but not more numerous or more varying in their character than the opinions on each and all of them held by canal officers.

EVILS OF THE PRESENT SYSTEM.

Bi-annual measurements, sending in returns of the areas watered, and the nature of the crops produced, during the hot and cold weather seasons, is in theory all that is just and proper; yet the warmest supporters of the system must admit that not only false returns of areas and a wrong classification of crops are often submitted, with the object of defrauding Government, but often large numbers of fields are omitted altogether in the returns. So frequently is this the case, that when one learns that, last year, no less than 1,425,702 acres of land were irrigated in the latter way, we may safely say that the actual area equalled 1,500,000 acres, or even as much as 2,500 square miles; and is this to be wondered at if we look a little deeper into this question? With returns of some three million fields of different descriptions of crops, by two different systems of irrigations, "tore" and "dhall," with different charges on each, with this revenue to be collected from 500,000 or 600,000 cultivators, living in some 10,000 villages, dispersed over an area as large as England, one would naturally ask, "Is it to be wondered at that Government should be defrauded on the one hand, and the cultivators sometimes oppressed on the other?" So long as they see an officer desirous to act justly, though firmly, in the execution of his duty, the natives are satisfied, even though, at times, this officer may pass a wrong order; and it is by this general feeling that the small body of Anglo-Saxons are enabled to govern India; but if the natives once suspect favouritism or worse, most serious complications may arise.

WHAT SHOULD BE DONE TO IMPROVE IT?

This is more easily asked than answered. I, however, venture to suggest that the engineering duties should be completely separated from the revenue ones, and a set of officers, be they engineers or not, should be selected for this latter

the commissioners of divisions (not district officers nor canal engineers) and the secretary of the local government for the irrigation or agricultural department. Their duties should be to receive a certain volume of canal water from the canal engineer, whose duty it would be to keep up the supply, and the works in order, while the irrigation officer has the sole responsibility of its distribution. My experience tells me that contracts, or rather settlements, could be made with heads of villages, in the first instance, for periods not exceeding five years, for a round sum yearly. Objections, no doubt, may be raised to this, and Government may on some occasions lose some revenue; but it does so at present by fields being omitted altogether from the returns, or by wrong classifications; so why not let the villagers make money honestly, rather than by having recourse to fraud? The strong argument in favour of this plan of five-yearly settlements (it may afterwards be increased to ten or twenty years) is the prevention of interference of canal underlings, and that the cultivator can raise what crops he pleases without having to pay more or less to Government. Thus, there can be no appearance of any bounty being held out to grow inferior crops, which sometimes does happen by the present system.

CONCLUSION.

The laws now suggested may appear novel, but I venture thus to make them public, after having arrived at most of them during the famine of 1860, and my experience since has gone far to confirm me in these laws, as may be seen in any of my canal reports I have carefully studied the subject; not in a library, but in the fields; not from books, but from men whose livelihood depended on it, both in the north-western provinces and the Punjaub.

DO WE REQUIRE IN INDIA CANALS OR RAILWAYS?

OPINION OF LORD DERBY.

(Expressed when he was Secretary of State for India.)

It seemed to be that because costly lines of railway were suitable for this country (before a line was constructed we had a complete system of canals adequate to our heavy traffic) they were equally suitable to India. He believed, and so did more competent judges, that that system of proceeding was a complete mistake. What was wanted in India was not costly lines for rapid travelling, laid down in a few parts, but a comparatively inexpensive, though slow, means of communication extending over the whole face of the country.—(Extract from Speech delivered before the Manchester C. S. Association, November, 1857.)

OBJECTIONS OF THE LIEUTENANT-GOVERNOR.

There is one thing essential to canals, and that is water. You may carry iron anywhere, but you cannot carry water to the tops of hills and the tops of plateaus. You cannot carry water with equal facility to every part of the country; therefore, it seems to me that the question between railways and canals is not one of general principle, but one of detail; that is to say, you have to look at the particular localities and the particular lines of communication; and, accepting the facts of the existing means of communication, you have to look to the additional lines you now wish to make, and to consider whether those particular lines can be best made by iron or by water. When you come to discuss that point, there are, as I say, local circumstances to be taken into consideration.

It seems to me—I say it with great deference, I admit I do not thoroughly understand the question, but I have had

occasion, with regard to the Godavery and other works, to go into the subject; the one panacea by which Sir Arthur Cotton gets over all difficulties is this,—he says if there is not enough water in the rivers in the dry season, you can store enough water in storage basins I cannot make out that that has yet gone beyond the stage of theory. I do not understand that there exists in the world such great storage basins as Sir Arthur Cotton suggested, and therefore I should like further information upon that point before I accept that as a means of getting over all these difficulties in regard to want of water, and in regard to canals going over mountains and into all sorts of inaccessible places.

SIR B. FRERE'S REPLY TO THE OBJECTIONS.

The more I have thought over the matter, the more convinced I am that Sir Arthur Cotton is right, that, dealing with a country like India, there is no difficulty in, I do not say producing the same entire freedom from obstacles that you have at sea, but in producing very great lengths of navigation on which the obstacles would be reduced to such a minimum that you would be very nearly as well off as you would be on an open natural water. This is a view in which those who know India best will agree with me if they will look at one or two simple facts. If you travel from say Calcutta by Lahore down to Kurrachee, where do you see any visible rise in the ground? You are obliged to take your level and to look very carefully at the waters as they flow to satisfy yourself that there is any difference of level throughout your whole journey. Hitherto what has been thought of most has been how to get your goods first to market; now I believe it is becoming more and more a question who shall get them cheapest, and no doubt cheapness is best attained by trusting to water. There can be no doubt whatever, allowing for deductions on either side for over-statements and over-estimates of cost, that for a given million of pounds laid out you can get more goods carried farther and much cheaper by canal than you can by any other mode. I do not mean to say you should stop making railways, I consider that the scheme of the Government of India in this matter of navigation canals falls far short of the necessities of India. I do not think you can deal with this question as if you had only a certain sum in your pocket to be laid out in one or other of two incompatible means of communication. I believe you have

resources far beyond what the most sanguine of us contemplate. You may lay them out upon railways, getting a bare 4 or 5 per cent., and you may thereby attain innumerable indirect advantages—advantages of education, advantages in the way of breaking down barriers between class and class, advantages in the way of opening the country throughout; but lay out the same money upon water communication, and I believe you may get, as Sir Arthur Cotton says, 10, 20, and 50 per cent even for what you lay out, taking water communication and irrigation together, and you will moreover enable your produce to come to market and to come to your railways in a far greater ratio than by any other mode in which you can expend your money.

SIR ARTHUR COTTON'S REPLY.

Another gentleman said it was impossible to carry canals in some places. I am not going to cut canals where it is impossible to carry them. What have I to do with impossible places when there are thousands of miles where they are possible? I am asked, Where are the reservoirs that could possibly hold the quantity of water that would be required for canals? There are 40,000 or 50,000 old native tanks in India; some of enormous dimensions, one of them being twenty-five miles in circumference, and capable of supplying thousands of miles of canal with water. These are works now actually in existence, and capable of supplying many thousand miles of canal with water at this moment. Then, as to the compatibility of navigation and irrigation works, the Godavery and Kistnah canals have been navigated for the last twenty years, and are being navigated at this moment. The Ganges Canal is at this moment navigated to a considerable extent. I grant there were certain defects in the construction of those works which materially affected the navigation, but they could be remedied for the merest trifle. So insignificant is the quantity of water required to supply a canal, and so insignificant is the cost of storing it, that, as I have said, if it cost £2,000 a mile to make the canal, it would only cost £100 more to keep it supplied with water.

COLONEL WRAGGE'S OPINION.

There seems to be rather a disposition to cast ridicule on the unfortunate Indian rivers. Why is it that the rivers are com-

paratively dry when they are most wanted? Because the rivers have been neglected. The rivers should be constantly supplied with water by having reservoirs in the hills. There are plenty of places where, during the monsoons, immense deposits of water could be stored during the dry seasons, which are now allowed to run to waste. Proper precautions are not taken to store up the water.

A COFFEE-PLANTER'S QUESTIONS ANSWERED.

(Questions by Mr. Elliott, Author of "Experiences of a Planter in the Jungles of Mysore," answered by Sir Arthur Cotton.)

May I be allowed to ask this question: Have you in view a system of canals that would equally serve the purposes which a network of railways would serve?—With some limitations. I do not say that canals can be cut everywhere, but they can on all the great lines of the country.

Suppose you take the plateau of Mysore, can you get down from that on to either sea?—I have looked into that particularly, and I estimated for a canal, for instance, from Bangalore to the Bellary, it would be perfectly practicable.

And from there again to the sea-port, Madras?—They have a line up to near Bellary.

I mean so as to come down to the western coast, which is a matter of some importance, in consequence of the opening of the Suez Canal; there is an abrupt chain of hills there. How would you propose to get out of that difficulty?—The system could be adopted which is adopted in England, of sending boats down long inclined planes—that is found to be perfectly practicable on the Monkland Canal. There, there is a flight of locks, and by the side of them an inclined plane, and I suppose the inclined plane cost a tenth of what the locks did; they transfer a boat down one hundred feet in seven minutes. You say access to that coast is of importance, on account of the opening of the Suez Canal. I say that is greatly over-estimated; the difference between the cost of freight of working steamers from London to Calcutta, and from London to Bombay, is only 2*s.* 6*d.* a ton.

There would be no water for the canal in that case either. I take it, in the high countries, at that season of the year, you could not get enough water for your canals?—Hear what an old engineer says on that subject. If it cost £2,000 a mile to make

the canal, it would cost £100 a mile additional to keep it filled with water, that is all.

If the rivers are dried up, where do you get your water from. I maintain that in that hilly country there is no room for reservoirs.—So insignificant is the quantity of water required to supply a canal, and so insignificant is the cost of storing it, that, as I have said, if it cost £2,000 a mile to make the canal, it would only cost £100 more to keep it supplied with water.

MR. R. H. ELLIOTT, IN 1872.

In order to secure the permanent safety of life, and the general interests of the people, we must look to water alone. Without this nothing can be done. If the financier comes to me, I tell him that the key of finance is population to pay plenty of taxes, that the key of population is ample and certain food, and that the only key to regular and ample food is to be found in water. If the general politician comes to me, I say to him that if we wish to hold our own in India this can only be done by rendering her people rich and contented; that this can only be done by developing the resources of the soil, and that this again can only be done by cheap and abundant water. If Manchester comes to me, I say that India can only become an active purchaser of her wares by being enriched; and here again we get to the one, the only answer. Within little more than the last ten years 2,814,529 of the inhabitants of India have died from starvation, and during the present year another famine has no doubt added, who shall say how many, victims to the tale. Place that fact side by side with the test of good government in all countries, the safety of life, and let any man say, if he can, that the base of civilisation has been firmly laid in India; nay, more, let any man deny, if he can, that a Government which witnesses such things and neglects to take every possible precaution against their recurrence, let any man deny, if he can, that such a Government may justly be spoken of as cruel and barbarous! These I know are harsh and uncompromising terms, but I make use of them because I am sure they are well deserved, and because I deem it best for both countries that the naked truth should be plainly declared.—(Extract from a paper, "What the true Interests of Manchester really are in India," 1872.)

THE TRAFFIC ON INDIAN RAILWAYS POINTING OUT THE NECESSITY OF WATER TRANSIT.

GOODS.

Class.	Tons	Per cent.
Lowest	2,333,132	59
Second class . . .	620,017	16
Third class . . .	367,144	9
Fourth class . . .	260,263	7
Fifth class . . .	164,518	4
Minerals . . .	210,926	5
Total tons carried .	3,953,000	100

PASSENGERS.

Class.	Fare.	Number	Per cent.
Third . .	3 pies	14,113,426	93 02
Coolees . .	$2\frac{1}{2}$,,	3,576,549	
Intermediate .	$4\frac{1}{2}$,,	523,740	6 15
Second . .	9 ,,	642,645	
First . .	18 ,,	144,215	0 83
Season tickets	— ,,	5,638	
		18,940,585	100 0

showing the goods traffic consists of low bulky goods, and the passenger traffic consists almost entirely of third class, first class does not even form one per cent. of the number carried.

FOURPENCE A TON PER MILE REAL COST OF TRANSIT ON INDIAN RAILWAYS.

(Questions by Mr. J B Smith, M P., Stockport, Lancashire, answered by the Public Works Secretary, P. Select Committee, 1871)

Although the 2*d*. a ton a mile was paid by the parties sending the goods, the Government have to pay another 2*d*. a mile as a subsidy, to pay the interest of the railway?—Approximately that is quite true.

So that the goods cost, in fact, 4*d*. a mile, of which the Government pay 2*d*. as a subsidy, is that so?—Well, it is true that some such sum was paid for them.

Now, do you think that if these railways were to pay their own expenses, it would be necessary to charge 4*d*. a mile per ton for the carriage of produce?—No, obviously not; nor do I think that it would, to anything like the same extent, if the railways were properly managed.

But we are taking them as they are managed at present?—I admit that, perfectly; but what I have said all along is, that

the system of management is by no means perfect.—(Minutes of Evidence, vol. ii. p. 415.)

£5 to £9 COST OF CARRIAGE PER TON BY RAILWAY.

What India really requires is a system of *cheap* communications with and throughout her remotest districts; carriage so inexpensive as to admit of the produce of her most distant fields being brought down to the coast at two or three rupees (4*s*. to 6*s*.) per ton. The G. I. P. Railway is carrying cotton from the valley of the Wurdah to Bombay (470 miles), but at a cost of £5 to £9 per ton.

For cotton, the Company charges special rates. On the Berar line their charges are—

Full pressed bales . .	18 pies per ton per mile
Half pressed ,, . .	28 ,, ,, ,,
Unpressed docras . .	34 ,, ,, ,,

In other words, all that the railway can do for Bombay is to carry cotton thereto from the interior at from 2¼*d*. to 4¼*d*. per ton per mile; and as Nagpore is 500 miles from Bombay, the carriage therefrom varies from £5 to £9 a ton. Such a rate might be borne while cotton was a shilling a pound, but with the staple down to 6*d*., and carriage on the Mississippi at one pie per ton per mile, it is not difficult to see the end.

Of what use is a railway to Jubbulpore, where wheat may be selling at 12*s*. the quarter, if the railway cannot carry it to the coast for less than 24*s*.?—(*Indian Economist.*)

COST OF CARRIAGE OF GRAIN THREE HUNDRED MILES BY WATER, RAIL, AND ROAD.

(By T Login, Esq., C E.)

It is shown that where grain costs only one rupee a maund, the cost of this grain when transported three hundred miles in India would be enhanced in price as follows:—

By ordinary canals . . .	14 to 20 per cent.
,, railway	39 ,,
,, carts on metalled roads .	76¾ ,,
,, ,, country roads .	100 ,,

It is also shown that all goods costing less than rupees 14 a maund, would prefer water-carriage, where time was not of much importance.

The advantages of a cheap mode of conveyance in an agricul-

tural country can hardly be over-estimated, and when we find that cotton from Saharunpore, Jugadree, Kurnaul, Paniput, and even Delhi is *now* carted to Ferozepore to be boated down the Indus, rather than sending it by rail to Calcutta, it is self-evident that, in spite of the moderate charges on the E. I. Railway, a still lower rate is necessary to secure the cotton trade. A navigable canal secures this, while at the same time it can be constructed at about one-third the cost of doubling and maintaining the railway line.—(Extract from Mr. T. Login's pamphlet on "Roads, Railways, and Canals.")

COST OF TRANSIT OF GOODS BY CANAL, RAILWAY, AND ROADS.

By canal	$\frac{1}{2}d.$ to $1d.$	per ton	per mile
,, railway (lowest rates) .	$1\frac{1}{2}d.$ to $2d.$	,,	,,
,, metalled roads . .	$4d.$	,,	,,
,, unmade roads . .	$6d.$	,,	,,
Upon bullocks . . .	$7d.$	,,	,,
Coolies	$8d.$	,,	,,

Upon good roads, metalled and bridged, a native cart will carry half a ton (1,200 lbs.); on a bad road, 600 lbs. Unmade roads in the rainy season are almost impassable, owing to the deep and full rivers.

The foregoing averages are liable to many variations in India.

SIR A. COTTON'S REPLY TO THE GOVERNMENT DIRECTOR OF INDIAN RAILWAYS.

Mr. Danvers says 15,000,000 tons are carried. He means that 50 tons are carried here and 1,000 carried there, and he adds them all together and says 15,000,000 tons are carried. The question is, what extent of traffic is carried along a certain piece of railway. When I say 1,900,000 tons a year are carried by the Nuddea rivers from the main Ganges to Calcutta, that is the actual quantity traversing the length of those rivers, and I compare that with the quantity carried along the length of the railway by the side of those rivers. Surely that is intelligible. What I am speaking of now is the average quantity carried all along the railway, and as far as I can make out by calculations from the blue book, they work out to about 60,000 tons—it may be 80,000, but that does not materially affect the question; the book does not give the exact average. By the side of that very railway are two miserable, unimproved, wretched navigations, carrying 1,900,000 tons—thirty times what the railway carries. Those rivers are only open four

months of the year; the rest of the year they have to go three hundred miles round to get to Calcutta by water. I am an advocate for steamboat canals, and one gentleman says he would like to know what I would do on the Indus. What could I do on the St. Lawrence? What has that got to do with the matter? I should be the last person to advocate the navigation of the Indus, because it is a bad navigation. Another speaker said he would like to send his produce by a river that runs into the Cauvery, but when he wanted to send it there was no water, and if there was any water he could not send it, because that particular river is a river unnavigable and unmaintainable. I do not advocate that rivers should be used whether navigable or not; and, moreover, what I have insisted on throughout is steamboat canals.—(Discussion E. I. Association, March, 1869.)

OFFICIAL RAILWAY REPORTS, SHOWING THE NECESSITY OF WATER TRANSIT FOR ALL INDIA.

The peculiarity of Indian traffic is the low value of the bulk of the goods offered, and the great distances they are carried. From these two causes combined, the cost of carriage at present rates forms such an addition to the prime cost of the class of goods to which railways must look for the bulk of their business, such as seeds, rice, and grain, as either to exclude such goods altogether from commerce or to compel them to resort to other means of reaching their destination when such other means exist.—(Extract from Mr. Danvers's Official Railway Report for 1871-72.)

TO WHAT EXTENT RAILWAYS INCREASE GENERAL REVENUES.

It is constantly asserted that the railways have increased the revenue, but I have never seen one attempt at any proof of this. When we investigate this, we find there is not the slightest reason to believe that it is so. Districts that have had millions spent upon them in railways show no increase of revenue whatever due to them. The effects of irrigation and water-carriage upon the revenue appear in the clearest manner by the progress of the revenue of the districts. Compare, for instance, Kistna with the nearest railway district, North Arcot, and the nearest non-railway district.—

	1843-4.	1871-2.	Increase.	Per cent.
Revenue of Kistna . .	£240,000	£550,000	£310,000	130
Revenue of North Arcot .	249,000	320,000	71,000	28
Revenue of Mundura .	234,000	300,000	66,000	28

That is, while an irrigation district has increased £310,000, or 130 per cent, in twenty-eight years, under an expenditure of only £300,000, the nearest railway district has only increased 28 per cent. in the same time, though about two millions have been spent in it on railways; and the next non-railway district has increased in exactly the same proportion, showing that the increase of 1 per cent. per annum is merely that due to the general improvement of the country from other causes. Tinnevelly, another non-railway district in which great irrigation improvements have been made, has increased in the same time from £270,000 to £450,000, or 66 per cent. It is impossible to mistake these facts.

The actual expenditure on railways has been 93½ millions, according to last year's Blue-book; and the debt was, in 1870, 20¼ millions, and is now about 30 millions, making the total amount sunk 123½ millions, the interest of which is 6 millions; and as the net profits were last year under 3 millions, the charge upon the Treasury is above 3 millions.—(March, 1873.)

OFFICIAL REPORT ON WATER-COMMUNICATION, 1873.

The delta canals of Madras are much used for boat traffic, as well as the high level and Cochrane's Canal. But it is in the belts of greatest rainfall, the delta of the Ganges, the valleys of the Brahmaputra and Irawadi, and on the coast of Malabar, that water is most largely used as a means of communication.

The rivers in the Bengal district of Naddea have long been used as fluvial highways.

The revenue derived from tolls on the Naddea rivers in 1871-72 amounted to £20,000. The whole outlay on Bengal canals during the year was £18,962, and the income £36,334, showing the existence of a great and increasing traffic.

There are two steam-navigation companies running steamers on the Irawadi, which made sixty trips in the year. There are also 19,400 boats employed in the Irawadi carrying trade.

On the Godaveri navigation works there was a steamer towing boats from the second barrier to the coast, which carried a total of 188,312 tons of cargo; and the *Wainganga* steamer continued the communication between the second and third barriers.

Malabar Backwaters.—The important line of water-communication, parallel to the western coast of India, which is included in the Malabar and Travancore backwaters, was reported upon

by Mr Robertson in 1871. By the completion of the cut through the Warkallai barrier, and by making another cut from the Venjali lake to the Tirur Station of the Madras Railway, there will be a continuous line of water-communication from Budagivi, north of Bepur, to Trivandram, the capital of Travancore, whence the Victoria Canal extends southwards towards Cape Comorin for fifteen miles, which is to be extended thirty miles further. The great value of this system of natural canals is best shown during the south-west monsoon. In its centre is the harbour of Cochin, which is capable of being made the finest close harbour in the world, ten miles broad at its southern end, and from ten to forty-eight feet deep. The canoe boats on the backwaters draw half a foot of water, and carry 2,000 to 3,000 lbs. each.—(Progress and Condition of India, 1871-72.)

TRAFFIC ON DELTA CANALS.

(By Col F H. Rundall, R.E.)

Facility and cheapness of communication are afforded by many lines of navigable canals permeating the delta. The extent to which they are used will be evident from the statement which shows the number of boats passing through the head locks. In the past year these amounted to 13,113 laden boats, measuring 337,117 tons, and 15,852 empty boats, making a total of 28,965 boats, or a rate of 80 boats per day. In this, the intermediate traffic, which does not pass through the head locks, and of which there is a large quantity, is not included. The number of boats registered in 1871 were—

Cargo boats	1,221,	average 27·8 tons
Passenger boats . . .	82,	„ 57 passengers
And including pleasure boats, the total number was	1,353	

From which licence fees, amounting to 39,324 rupees, were levied.

A traveller along the Godavery canals cannot fail to be struck with the number of passenger boats Eighty-two were registered last year, licensed to carry on an average fifty-seven passengers. Supposing that, on an average, there were only thirty people per boat, the passenger traffic would amount to 2,400 people carried daily. The average distance travelled by each person, probably, being not less than twenty miles, the daily traffic will be represented by 48,000 people, and the yearly traffic by

17,520,000 passengers through one mile. The price at which they are carried is 12 miles for 1 anna. Similarly, assuming the distance traversed 40 miles, the ton mileage of the goods would be 13,484,680 tons.

There can be no doubt but that these results have fully borne out the far-sightedness of Sir Arthur Cotton in insisting upon the paramount importance for intercommunications of the cheapest character. Sanguinely as he was wont to look forward to the time when the Godavery canals should be covered with traffic, I doubt whether even *he* expected that within so short a time traffic could develope to the extent it has done. Certainly the results in that district convey an important lesson in the designing of irrigation projects which are intended to affect large tracts of country where expensive land carriage has hitherto formed the only means of transport.

RELATIVE VALUE OF RAIL AND WATER.

I am no opponent of railways for India. I am far from underrating the strength they may confer on the Government, or the wealth they may bring into the country, but there can really be no comparison of the relative value to the people of railroads and of works for providing water. There can be no question at all as to which description of work would be most appreciated by the natives, or would bring more quickly a return for the capital invested. It ought to be a subject of regret and of something like shame, when we reflect upon the vast expenditure upon railroads, entirely at the cost and risk of India, as compared with our niggardly outlay and negligent stewardship with regard to canals and irrigation. In the south of India and in the central provinces, and in many other districts under our rule or subject to our influence, hundreds of large tanks are lying ruined or destroyed. The genius and energy of Sir Arthur Cotton, who—come weal, come woe, to India—will be recognised in time as a true prophet, led to the gigantic achievements of the Coleroon, Kistna, and Godavery. These are his personal triumphs; but small has been the effect of his comprehensive schemes and general exhortations, though urged with so much eloquence and earnestness. Recall his timely warnings, and then look at the whitening bones of starved and fever-stricken wretches in Orissa that testify to the want of water where water abounds.—(Lieut.-Col. F. Tyrrell on Public Works in India, p. 19.)

DUKE OF ARGYLL'S CONCLUSION—MYSORE RAILWAY.

Our first choice ought to fall upon irrigation rather than upon railways, and the funds at our present and prospective disposal should be devoted to the improvement and re-establishment of the ancient system of irrigation, before any outlay is applied to the construction of a railway.—(Railway Report, 1872-73, p. 51)

CANALS *v.* ROADS.

The extreme rainfall at one season, and the extreme heat at another time, cause the maintenance of a road to be a very difficult matter; more particularly in many parts of India. Where the vast cotton soil plains exist, it is most difficult to cross them by any road, unless of the most expensive description Canals, on the contrary, could always be kept in order, and they would also allow of the planting of trees along their course, which would have the two-fold effect of lessening the evaporation and rendering the rainfall more abundant. The formation of canals would enable us to plant useful trees in the place of the usual jungle, which might also become a source of revenue. This has already been carried out on a small scale.

The difficulty is not, however, so much the understanding of the figures, that can be shown as the results of the railway or of canals. It is the difficulty of stopping a huge and gigantic system of patronage, that has now enveloped India in her folds, and will, at all events, bring disgrace upon us. Could anything be more short sighted, could anything be more painful, or exhibit in stronger light the total disregard to the development of the resources of the country? From about the year 1860 to the year 1871, thirty millions of pounds sterling were expended on iron in England for Indian railways; up to the present time our adopted waifs have led us to railway debt, insecure financial position, and famine. Irrigation works may not possess that *prestige*, nor produce that *éclat*, that belong to railways. It may require some power of mind to stem the popular idea of railway infallibility. But irrigation works will be found quite as capable as railways, and far more profitable. Irrigation also opens the only door for putting our finances on a real solid foundation.—(The Future of India, by Lieut.-Col. Tyrrell, 1874.)

RAILWAYS AND INDIA-OFFICE PATRONAGE.

Year	Ships Employed	Tons of Goods Shipped.	Value of Goods Shipped.
1860	2,605	2,094,686	£10,431,976
1861	407	181,621	1,669,443
1862	280	138,013	1,487,582
1863	279	166,840	1,285,464
1864	233	102,318	1,018,164
1865	442	199,157	1,729,543
1866	581	312,227	2,527,757
1867	512	333,329	3,052,652
1868	364	188,858	1,849,554
1869	455	211,750	1,432,784
1870	461	263,449	1,688,209
1871	307	168,049	707,765
1872	318	66,534	655,822
Total .	7,244	4,427,831	£29,536,715

CANAL PROFITS IN ENGLAND ASSESSED TO THE INCOME-TAX IN GREAT BRITAIN.

Length of Canals, 2,400 miles.

Year 1862	£961,165
1863	937,774
1864	935,626
1865	899,717
1866	962,206
1867	823,091
1868	743,339
1869	714,322
1870	746,591

According to the Blue Book, 669, 1872, p. 352, the number of canals in Great Britain is seventy-four; length of canals, or navigation, 2,431 miles; upon fifty-two of the above canals, in 1868, the gross amount of tonnage conveyed on 2,032 miles of canal was 23,320,832 tons. There are no returns from the twenty-two canals.

The above profits, dividing by the length of canals, would give £400 to £300 nett profit per mile of canal.

FINANCIAL RESULTS OF RAILWAYS.

Mileage, 5,050, up to March, 1870; capital outlay, £91,000,000; this does not include the following amounts, viz.:—

	£
Loss in exchange	4,000,000
Land-compensation	7,000,000
Interest paid, less traffic receipts . .	17,500,000

If we include these items, the total capital outlay on 5,050 miles of guaranteed railways, almost all single lines,

	£
Amounts to, round numbers, the sum of	120,000,000
Guaranteed interest, at £5 per cent., on 120 millions, is	6,000,000
Total nett traffic receipts . . .	3,000,000
So that the loss in working, every year, is	3,000,000
But, shown in financial accounts, is .	2,000,000

because loss in exchange, and other items, are not included.

Thus the Government pays directly from the taxation of the country to guaranteed railway companies, *every year*, the loss in working railways—an amount exceeding £2,000,000 sterling. Increase in mileage open does not increase nett recepts.

	£
In 1866, mileage open was 3,252 miles, and loss in working per mile open, was	169
In 1872, mileage open was 5,187 miles, and loss in working per mile, increased to	335

showing that increase in mileage open increases loss.

Taking, not one year, but an average, from 1865 to 1872, and even including in that average the exceptional and prosperous years of the American war, the result of railways, calculated from figures given in the statistical abstracts presented to Parliament, is as follows:—

	£
Passengers receipts per mile open	412
Goods receipts per mile open	881
Total receipts per mile open	1,293
Working expenses per mile open	696
Nett receipts per mile open	597
Guaranteed interest at £5 per cent. per mile open .	941
Nett loss, paid from taxation, per mile open . .	344
Cost per mile of railway	19,530

The above average, from 1865 to 1872, shows that the connection of main lines between the capital towns of Bombay, Calcutta, Madras, Lahore, &c., instead of diminishing, has increased the loss in working railways. India is so poor,—an agricultural country, and in a poor country, as actually shown in practice, railways are a luxury, and cannot be worked with profit.

The Indian Finance Minister stated in his budget speech,

April, 1873, that "the nett charge for guaranteed railway interest is now expected to amount to more than £2,000,000, which is considerably larger than any sum ever yet shown on this account, and suggests serious consideration. This charge is made out in this wise: The guaranteed interest amounts to £4,665,000 on a capital sum of £95,000,000. Against this there is a set-off of £2,548,000, estimated nett traffic receipts on 5,073 miles of open line, which receipts arise from £6,864,000, estimated gross traffic earnings, less £4,316,000 working expenses. The nett traffic receipts deducted from the guaranteed interest leave the £2,117,000 as loss to the State."

TWENTY-ONE MILLIONS LOSS IN WORKING RAILWAYS PAID FROM INDIAN TAXATION TO GUARANTEED RAILWAY COMPANIES UP TO 1872 BEYOND THE AMOUNT OF NETT REVENUE.

Railway Company.	Miles	Nett Loss Paid. £
East Indian, Main Line	1,503	4,484,319
,, Jubbulpore Line		1,258,737
Great Indian Peninsula	1,278	5,040,461
Madras	835	3,000,697
Bombay, Baroda, and Central India	416	2,144,854
Scinde, Punjab, and Delhi	676	3,784,141
Great Southern of India	168	484,080
Eastern Bengal	156	528,364
Oude and Rohilkund	396	547,310
Carnatic	18	76,155
Total	5,446 miles	£21,349,118

Yet the State policy is to construct more railways, and the Government proposes to spend additional capital outlay of £21,000,000 up to 1878, and on irrigation works only £8,000,000! Now let us glance at the financial results of irrigation works in operation.

FINANCIAL RESULT OF IRRIGATION WORKS.

Capital outlay on works in operation, up to 1872	£6,000,000
Outlay on works under construction, up to 1872	4,000,000
The official figure for works in operation is	8,000,000

This capital outlay of £8,000,000 has given India—

Main canals adapted for steam navigation	2,650 miles
Branches for distributing water in fields	4,693 ,,
Total acres watered by State canals is	4,000,000
The direct water-rates receipts in 1872	£850,000
Repairs and maintenance in 1872	£288,700
The nett water receipts in 1872	£561,000
Returning, on capital outlay, profit	10 per cent.

without taking any increase in land revenue due to State irrigation works, as shown in detail in these pages.

The Government Report, dated July, 1873, states, "The net result of the entire outlay on irrigation works up to the year 1873 is a return of £413,610 per annum above the interest at 4 per per cent. per annum on the first cost of the works."

The benefits derived by the people are every year—

Each watered acre produces crop, value	£2
So for 4,000,000 acres watered by canals, value is	£8,000,000
Or, at £3 per acre, value of produce is . .	£12,000,000
Cost of works per irrigated acre is £1 10*s*., or say .	£2
Cost per mile of navigable canal is . . .	£2,132
Or, say in round numbers, per mile . . .	£3,000
Against cost per mile of railway	£18,000

Agricultural produce is carried on canals at two farthings per ton per mile—say a penny per ton per mile; while on railways the lowest charge is twopence per ton per mile. The saving in transit of goods by cheap water carriage is estimated, per annum, at some millions. In the Madras deltas all the traffic is by water.

The increase in land revenue, due to State irrigation works, is calculated—

At per acre watered	8*s*.
So, for 4,000 000 acres watered by canals is .	£1,500,000

land revenue derived by the State, due to State irrigation works. The Government assessment on wet lands is three times more than on dry lands.

What room for extension of irrigation canals there is in India, may be judged from this fact, that 125,000,000 acres are under cultivation, and, according to the *Agricultural Gazette*, 90 per cent. of the land is under dry cultivation, and only 10 per cent. under wet cultivation, including all lands watered either by wells, tanks, or canals.

Very strange it may appear that, notwithstanding such wide field for extension of irrigation, and such comparative results of railways and canals in India—after a capital outlay of £100,000,000 on railways (in working which, already a loss of £20,000,000 has been paid from the taxation of India) the Government has taken in hand State railways, the proper name of which would be military railways. A further outlay on

£21,000,000 is proposed for railways up to 1878, and only £8,000,000 for irrigation works, as will be seen from the following figures taken from the official memorandum, dated Simla, July, 1873. It shows the probable expenditure on new guaranteed and State railways compared with water-works in each year from 1873 up to 1878 is to be as follows, according to Government notification :—

Year.	Railways.		Irrigation Works.
	State.	Guaranteed.	
	£	£	£
1873	782,000	986,000	969,000
1874	2,232,000	1,525,000	1,266,000
1875	3,000,000	2,000,000	1,475,000
1876	3,000,000	825,000	1,449,000
1877	3,000,000	400,000	1,401,000
1878	3,000,000	200,000	1,304,000
Total	£15,014,000	£5,936,000	£7,864,000

or in round numbers £15,000,000 sterling on State railways, £6,000,000 on guaranteed railways—in all £21,000,000—and only £8,000,000 on irrigation works.

2,500 miles of additional railways, when finished, at £350 loss in working per mile open, will increase the annual loss by nearly a million sterling, so the Indian tax-payers, instead of paying £2,000,000 every year, as at present, will have to pay £3,000,000 every year.

The policy of Government shows conclusively that the preservation of lives from famines and the advancement of the material progress of India are considered by them of much less importance than the construction of railways chiefly for military purposes.

To keep the military object in view, and not care for the comfort and well-being of two hundred millions of people, to prosecute irrigation works only with vigour during famines, is a policy which cannot be called enlightened or Christian. The unnatural deaths of a million and a half who died in the Orissa famine in 1866,—all the guilt of putting to death millions of human beings in preceding famines, rendering children orphans, and bringing distress in every shape on the survivors—may be justly and righteously put at the door of the administration who rule over India.

HOT CONTROVERSY BETWEEN COL. CHESNEY, R.E., AND SIR ARTHUR COTTON, R.E.

LAND *versus* WATER CARRIAGE.

COL. CHESNEY.

I have read carefully Sir A. Cotton's Memo., May, 1871, and in view of the importance of the interests involved, I feel bound to state my opinion that Sir A. Cotton's argument in favour of navigable canals for India as compared with railways is a mere tissue of the most transparent, though of course quite unintentional, misrepresentations.

SIR A. COTTON.

The Secretary of State for India has called for a reply by one of the Railway Official Advocates, to my Memo, and has honoured me with a copy of it, showing that he is really anxious that the subject should at length, after twenty years, be honestly and publicly discussed. I would now proceed to my reply to the paper sent me by the Secretary of State.

JUGGLING FIGURES.

The cost of railways is set down as £96,000,000
Length of ditto . 4600 miles
Hence is deducted a cost per mile of . . . £21,000

But, as is clearly shown in the Blue Book, the cost here stated is that on the 6,249 miles made *and still in progress;* and not the cost of the 4,600 *completed.* These figures are therefore mere juggling.

CERTAINLY NOT.

The answer to this is that the Blue Book states that the *estimate* for the complete East India Line is £27,500,000 for 1,280 miles, which is £21,500 a mile, and, adding one-twelfth for land, £23,000; for the Baroda Line, the estimate £8,500,000 for 390 miles, or £21,700 per mile, and adding one-twelfth for land, £23,500; Great Indian Peninsula, £22,200, Madras, £13,900, Baroda, £23,500, Scinde, £22,100; Great Southern, £10,800; Eastern Bengal, £20,600, Oude, £9,300, South Eastern, £21,000.

MAIN LINES NEARLY EARN FIVE PER CENT.

The startling conclusion is arrived at that the actual cost of carrying goods by Indian railways is 4*d.* per mile per ton, and double the charge made Sir A. Cotton is of course quite aware when he makes this absurd statement, that all the main lines are

NO, NOTHING LIKE IT.

The following is the statement in Blue Book, 1870, showing the loss paid to each company. . . . To all these losses must be added one-twelfth of the interest paid on account of land, &c., besides the interest on debt of 20¾ millions (par. 41, B B.), so that, instead of *all* the main lines

now very nearly earning their five per cent. dividend.

The fact is, it will not be possible to predicate anything precise concerning the traffic of Indian railways till the main trunk system has been completed and in use throughout for three or four years.

It does not in the least follow that if the Indian Government had not made this expenditure (for interest on railway capital) a charge on the revenue, the saving would therefore have gone to diminish the amount of loans raised. It is just as likely as not that the annual loans would have been as heavy as ever, and that the saving would have gone to increase the public works' grant or some other source of expenditure.

paying very nearly five per cent., *not one* is paying it, and the most profitable is deficient £20,000, besides £120,000 interest of cost of land, &c., together £140,000; and this, besides the interest of the debt on this railway of 7½ millions (par. 41), £370,000, in all £510,000 a year paid out of taxes to support the most profitable railway in India.

No conjuring in the world can get over the consequence that if only 2½ millions are paid by works costing 120 millions, the Government are losing 3½ millions a year.

CANAL COST UNDERSTATED.

The average cost of the Ganges Canal per mile is very greatly understated by him. Moreover, if the accumulated interest and cost in maintaining it for the years during which it did not pay its expenses were added, as has been done in the case of railways, the virtual cost would be largely increased. It is further a complete delusion to regard the cost of canal-making as a thing which can be set down at an average price, so much per mile for any part of India.

The cost of making a canal depends on three things, the supply of water, the slope of the ground, and the drainage to be crossed. The Ganges Canal was cheap, because all these conditions were favourable. The Kistnah and Godavery deltas are still more favourable for such works; but because the Nile affords good navigation in Egypt, it does not

HERE ARE MY DATA.

He says the average cost of the Ganges Canal is very greatly understated, again, not a figure or a word to show it. I give the total cost of the Ganges Canal and its length, and then allowing for the cost of irrigation works, thence deduce the cost per mile of navigation canal, and am most certainly right in that deduction, and I cannot doubt that, if I was wrong in these figures, he would have shown it

The cost of the whole of the Ganges Canal works is £2,300,000. Of this, about one million was spent on bringing the water from within the hills, through a tract of country such as we have nothing to do with on the main lines of India. Of the remainder a large portion was of course spent in distribution, &c., leaving much less than a million for the 700 miles of main canal, or from

follow that the same river will fulfil those functions in Abyssinia.

Under certain favourable conditions, as where a backwater can be created along the level of the coast without locks, or in the case of the deep tidal creeks of the Gangetic delta, a great navigation can be profitably conducted, because there is little or no expenditure involved to create it Just so is the navigation of the ocean, cheap and profitable.

But Sir A. Cotton fails to see that where these favourable conditions are absent, the case is altogether different, and when he proposes extravagant schemes for canals running over hilly barren tracts, with expensive locks and artificial banks in light friable soils, and in addition a precarious water supply, he has nothing to go upon but his own crude assertions, unsupported by either fact or reason.

It is surely time that the public purse should be closed against demands based on such vague representations. Sir A. Cotton, I submit, might be asked to give a specific design, showing the depth and breadth of the canal he proposes, for the navigation of steam-boats at 16 miles an hour, with a specification of the sort of embankment he would construct to resist the wash caused by boats moving at that speed. Also to specify the number, size, and construction of the locks (on the proposed line from Madras to Bezpoor, with a summit level of about 1,500 feet), that would be emptied and filled "in a minute, or much less," and the size and form of the lock gates, and the thickness of the masonry required to resist the scour, caused by locks of this novel kind If these quantities of earthwork, iron-£1,000 to £1,500 per mile, for a canal varying from 50 yards to 10 yards broad, or an average of about 30 yards.

The Kistnah and Godavery Canal, 90 miles long, 25 yards broad, cost under a £1,000 mile. On all the main lines of India the cost now would probably average £2,000 or £3,000 a mile, for a canal 30 yards broad

When we hear that the Lower Ganges Canal, of 200 miles in length and 100 yards in breadth, is estimated at 2½ millions, including irrigation works, giving £12,500 a mile for the total cost, and allowing one-third for distribution works, and taking one-third of the other half for a canal 30 yards broad, or £3,000 a mile, for a steam-boat canal, we are satisfied that although the estimate may be somewhat too high or too low, it must be substantially correct, because it agrees well with the cost of canals already executed in similar tracts

Toombada Canal—This was in the heart of the peninsula, in the most difficult line of country in which a *main* canal could be required—a rocky, undulating country, with a fall of 400 feet in 190 miles. The locks on the line are very large, I believe 150 feet by 20 feet. The actual cost of such canals already executed is £4,000 on this line. An average of £3,000 would thus from actual data carry us through all the main lines of populous country.

The estimate for the Main Soane Canal:—part of the line is £4,000, for an enormous irrigation canal, at least 60 yards broad, certainly double the size of a mere navigation canal

The Damooda Canal is estimated to cost half a million for 100 miles, including the irriga-

work, and masonry be then priced at current rates, and the figures tested by some experienced engineer, the Government would then be in a position to judge whether these schemes be sober or fanciful. tion works, or (allowing half the cost for these latter) £2,500 a mile. And Col. Chesney says on this very line of country a canal, 30 yards broad, would cost £30,000 a mile. What can we think of such reckless assertions as these?

I have omitted the objection of the expense of water for canals. A tank has been finished near Sholapoor, containing 120 millions cubic yards, besides what would pass through it in the monsoon, probably 40 million more. It cost £80,000, or, at 7 per cent., £5,600 per annum—£35 per million cubic yards I need not give the calculations in this paper, but at this rate the actual cost (with not a favourable site for a tank) of water for a canal would be almost imperceptible. The lockage water, for instance, would be about 10 cubic yards for a ton of goods, and this would of course pass it the whole distance from the head level of the canal to the coast—perhaps 500 or 1,000 miles.

The objection of the locks is little more than imaginary. A vessel need not be detained two minutes by a lock with a lift of 15 or 20 feet. It is only to make the water-passages capacious, instead of 2 or 3 feet square, as they were made on the old canals.

We certainly must have an estimate for each individual line, but the very basis on which we proceed to take the trouble to make such estimates is now that we have such overwhelming data from *actual* costs and results to assure us that we are on sound ground, and that we have unquestionable standards by which to test those estimates.

Col. Chesney then proposes that I should be called upon to

project a steam-boat canal. I am rather *passé* for such a work now, but, if called upon, I would do my best, but he proposes that my plans should be submitted to an experienced engineer. I am afraid he would be puzzled to find an experienced steam-boat canal engineer, or one who had had anything like the experience I have myself had in canal engineering in India.

INJURY TO CANAL BANKS.

It is found on the Ganges Canal that steamboats worked at a very slow speed are extremely injurious to the banks

REMEDY IS EASY.

The banks are easily protected by sloping off the upper part, or lining them with stones for a yard in breadth, as in the Gloucester Canal. And with a screw there is no great wash on the banks. A high speed does not cause a very heavy wash except with paddles. Even with paddles, at eighteen miles an hour, with feathering floats, there is no wave raised of any consequence. What loads of these sorts of things were said about the Suez Canal! How the banks were to be washed down by the steamers—how it was to be filled with sand, &c. These fancies all vanish before a man when he sets about the work.

COUNTRY FAVOURABLE TAKEN UP.

The fact is that the ground most favourable for the construction of canals in India has already been taken up. Just as in a new country the best soils are those selected to be brought first under cultivation, and the probability is that future irrigation works, with certain exceptions, will be more costly and less remunerative than those which have been already undertaken.

NO, NO.

There are tens of thousands of miles in India just as favourable to canals as those already utilised. The canals now planned on the Lower Ganges, on the Damooda, on the Sutlej, the Jumna, and the Indus, are all as favourable as any executed. About lines of canal across the peninsula being impracticable, I must observe that he has not had any experience in such works. I have examined most of these lines, and have had great experience in public works, and I may say confidently that they are all perfectly practicable, and at a moderate cost.

GODAVERY NAVIGATION WORKS.

Money has been spent upon a few miles of the upper part of the Godavery, and Sir A. Cotton talks about creating a water navigation at £2,000 per mile. One might just as well talk about opening a water navigation from London to Bombay at £25 per mile by spending £100,000 on a dock at Blackwall. It passes through one of the most unhealthy countries in the world Except at the end, there is no population or cultivation. The river runs through a fever-haunted waste, peopled mostly by savage aborigines. The navigation will, according even to the sanguine promoters, be open only for a part of the year. The navigation will, at its best, be imperfect and dangerous. Only steamers can be used, the current in parts being too strong to row against. On the other hand the river Jumna, between Delhi and Allahabad, passes through a highly populous, healthy, and fertile country, in fact, through one of the greatest corn districts in the world Its natural navigable facilities on this part are probably very superior to anything that will ever be accomplished on the Godavery, where indeed navigation will only be kept open at a painful cost of life.

MISSTATEMENT

Compare this with what I do say—"The money already spent is £600,000, including various things that don't belong properly to the part opened, 230 miles" I state a simple fact I must express my astonishment that an officer should thus dishonour himself. This navigation of 230 miles is now open and in constant use. About £200,000 more will complete the second barrier, when 400 miles will be open. The locks are very large, I believe 30 by 200 feet. Europeans have been living there for ten years on the works, so that the statement is far from the truth It is now worked by native boats all the year round. The authority is the actual report on the present navigation by steam. Then, if there are 20,000 tons traffic from such a tract, what will there be when the second barrier is opened, and several millions of people are brought within the influence of the river? It is true that 150 miles of it is a very thinly populated country, but this does not affect the question The country which it is to connect with the port is a most fertile country, and a coal field of excellent quality with seams thirty feet thick, and only wanting a cheap communication. On what possible grounds can the line of water carriage by the Godavery, costing £2,000 a mile, be ordered to be abandoned, and a new railway be ordered to be made at £6,000 a mile to carry coals from Chanda to the Nagpoor Railway, instead of improving the Wurdah at £2,000 a mile? Is it right to continue to misapply the revenues of India by rejecting cheap water lines to carry at low rates, and executing expensive land lines to convey at high rates?

TRAFFIC ON GANGES CANAL.

There is navigation on the Ganges Canal, which, although imperfect, is probably better than that of the Godavery is likely ever to be, but only the merest fraction of the traffic which goes on the neighbouring railroad has taken to it. Facts like these are, I submit, worth any amount of vague predictions.

WHY THERE IS LITTLE TRAFFIC.

Because it is not fit for traffic. It is full of defects. Yet in 1868-9 the traffic was 46,000 tons, or as much in this extremity of the country as the railways are carrying on an average on the main lines of the country through and ending at the great cities, Bombay, Calcutta, Madras, Benares, Allahabad, &c. One of the many defects was the low bridges, which would not permit a fully loaded boat to pass. "Estimates for raising twenty-five bridges have now been passed, and the remaining twenty-three are being estimated" I have no doubt that other defects are now being corrected. The down freight of goods other than cotton is $\frac{7}{8}d.$ per mile, and the up freight $\frac{1}{2}d.$, that is with human labour and in spite of defects. What would the traffic on this canal be if all its defects were corrected, if steam were used, and if it were supported by a subsidy of £500 a year per mile from Government as the railway is, sufficient to pay the freight of 250,000 tons a year at the present rate of $\frac{1}{2}d.$, so that that traffic would be carried free? A late Governor of Bengal told me that he had always thought a canal a very tame thing, but he was perfectly astonished when he first arrived on the bank of the canal to see a roaring torrent. When I was on the canal I called upon the agent of a navigation company to give me his account of the navigation, and he gave me a report of such numerous defects as made it almost worthless. One was that the approaches to the locks were so winding, narrow, and silted up (having often only a foot and a half or two feet of water) that they were almost impassable, and this was only one of many defects,

especially the strong current and the torrent above the weirs. The engineer having no idea of the importance of water transit and no wish to promote it (all the favour of Government being bestowed upon those who decried it and supported land carriage), of course it was never put into an effective state.

WHAT IS THE COST OF TRANSIT?

I submit that, in his view of these specimens of Sir A. Cotton's accuracy in figures, he should produce his proof of the statement that it is only $\frac{1}{16}d$. per ton per mile, before the statement is accepted. It is quite incredible, being utterly opposed to the results obtained in other canals in Great Britain of which the accounts have been made available. I presume he has taken the cost of *haulage only*, without regard to the interest on capital, which he has so bountifully heaped up in the case of railways, and omitting also all charge for repairs and cost of management. If this be so, then his comparison is about as valid as if one were to put the cost of feeding a horse against that of making a railroad, and then to declare in favour of the greater cheapness of animal draught over locomotive power.

HERE IT IS.

Look at the Duke of Bridgewater's canals, the Weaver Navigation, and many others in England, and the Erie and St. Lawrence canals in America, each carrying from one to two millions of tons per year in the midst of double railways. The New York States canals are paying their interest and carrying at $\frac{1}{3}d$. per ton per mile, including tolls and carriers' profit, where money is not more than one-fourth the value it is in India, equivalent to a charge of $\frac{1}{12}d$. there, against 2*d* the railway charge in India, though the canals are only open for seven months.

Costs of transit given in the report on the Erie Canal, in the United States for 1853:—Ocean, long voyage, $\frac{1}{18}d$.; lake, $\frac{1}{9}d$ to $\frac{2}{9}d$, Hudson River, $\frac{1}{7}d$., Erie Canal, $\frac{2}{9}d$., ordinary canal, $\frac{2}{7}d$. These are taken from a State report in a country where money is only about half the value it is here, and eighteen years ago. In a paper of this or last year the actual present cost in the Erie Canal is stated from $\frac{1}{16}d$. to $\frac{1}{11}d$. with horse draught, and at $\frac{1}{32}d$. by steam power.

INDIANS SCARCELY MOVE ABOUT.

Why should the most conservative peasantry in the world want to be always moving about?—(October, 1871.)

BUT THEY DO.

Many years ago I took the passengers' traffic on one of the great roads in Tanjore; it was 1,200 *male adults* a day, or 400,000

a year. What's the use of shutting our eyes, and saying we can't see?

The question with us surely is not—Why should they do it? but rather, How can we provide for that want with the least expense and the greatest convenience to them?

Is it not curious that the very man who asks this question, "Why should they?" &c., entirely approves of spending 120 millions on railways to provide for that want on a very few lines, leaving all the great mass of India still untouched?

BENEFITS OF IRRIGATION WORKS.

(Extract from Col. Chesney's work, "Indian Polity")

It is to prevent, or, at any rate, to alleviate, the effects of these awful calamities, that irrigation works are needed in India Even as an insurance against the direct loss of the land revenue, which must necessarily be foregone when the people have no crops to sell, such works are at once extraordinarily remunerative to the State. The famine of 1837–8 involved a direct loss of £500,000 sterling on this head; the Ganges Canal is estimated to have prevented at least as much during the famine of 1861. Yet the direct saving in land revenue is obviously only a part of the saving which thus accrues. A great calamity of this kind cannot fall on a country without paralyzing the whole course of trade and business, and the effect must necessarily make itself felt in every branch of the national revenue. The loss of public revenue, again, is but small compared with the destruction of national wealth resulting; and this it must be the

CONCLUSION.

In 1828 I was ordered to try and save Tanjore from the ruin of its irrigation which was then threatening. The works which I projected and executed to a great extent have been followed by an unbroken progress and prosperity in the district. The revenue, which was then £420,000 a year, was last year £710,000, more than double any other district of India, excepting Godavery and Kistna, which have been treated on the same principles. The Godavery and Kistna Districts, which were in 1845 in a disgraceful state of poverty, were then ordered to be treated in the way that had been so successful in Tanjore. The works which I then projected, and to a great extent executed in Godavery, have cost £500,000, and those projected by Col. Atwell Lake, and executed by Col. Orr and others in Kistna, have cost about £300,000, together £800,000, and they have been the means of raising those districts to a state of prosperity.

I must not boast, but acknowledge God's gracious hand in so

duty of the Government, as representing the interests of the general community, so far as possible, to prevent. And, after all, the loss of wealth, whether public or private, is surely but the lowest ground on which to base the argument for active measures. The prevention of the miseries of famine should alone be a sufficient, as it ought to be the leading, motive to action. It is not as if the affair were a speculative one, and that the question were one of possible calamities and doubtful remedies. Droughts have occurred in India so frequently that their occurrence before long, in some part or other of the country, is reasonably to be expected; and famine, as the certain effect of drought, *can be prevented by irrigation* Here, then, is clearly one of the most important duties that can be placed before the Government of any State. The task is one that only the Government can undertake, for it is not merely to carry out projects which promise to be remunerative in the ordinary sense of the word, it is to extend irrigation, wheresoever irrigation may be possible, throughout the country. Till that is done, and the danger of famine has been guarded against to the fullest possible extent, the English in India may replace anarchy by peace, and may distribute equal justice, and remove ignorance, but it cannot be said that they have fulfilled their whole duty to the people of India. (See the paper, "At what Cost Canals can be made navigable.")

helping and blessing us; but surely I may fairly point out the fact that my opponent says not a word about these works which I *did* project and execute (most of them), and objects to me those works which I neither projected nor executed, because his object is to make out that I am starting crude notions, without any practical experience. Surely if any man may claim it, I may claim to be a practical man.

If the canal is required for coals or salt, it is equally required for rice, building materials, and 99-100ths of the whole goods traffic of India, for there is no object whatever in carrying them at high speeds any more than coals, the sole question with all being cost.

The points I insist on are—

1. That water carriage, even with human labour, is cheaper than land, even with the help of steam.

2. That nobody can discover a reason why steam is to be applied to land carriage, and everything else in the world except inland navigation.

3 That the most perfect steamboat canals can be cut in India for a fifth or a tenth of what single railways have cost in India.

4. That boats can be propelled by steam at ample speed for all purposes.

5. That for 19-20ths of both goods and passenger traffic high speed is not wanted at all in India.

6. That wherever there is even wretched water carriage almost all the traffic goes on just the same as before the railway.

7. That it is impossible a country without good water carriage can contend with one that has it.

8. That the railways have laid the burden upon India of £1,750,000 a year, to make up the interest to the shareholders, besides £2,000,000 more the interest of their debt of £30,000,000, and of the cost of the land, &c., which is not included in the Blue Book accounts. What would be the state of Indian finance now if we could recover this £30,000,000, and be freed from £3,750,000 a year that we are paying for this mistake?

EXAMINATION OF SIR A. COTTON, K.C.S.I., BEFORE THE PARLIAMENTARY SELECT COMMITTEE, 1872.

RESULTS OF MADRAS IRRIGATION WORKS.

(Examination by the Chairman.)

Will you be good enough to state what offices you have held in India latterly?—I have been almost all the time that I have been in India employed in civil works in the Madras Engineers. My first principal work was the irrigation of Tanjore in the year 1828. After that I was employed in various charges which I had, but the principal works that I had were the Godavery Delta Works in 1845. I projected the work; the district was in a state of great disorder. The head of the delta is 40 miles from the sea. We constructed a weir across the river at the head of the delta, and led off from it three main canals with various branches which conducted water to the whole of the delta, and distributed it over about half the delta.

Was it a high-level surface of water?—Yes, entirely.

So that it flowed by gravitation over the land?—Yes.

Can you state how many acres were brought under irrigation by those works?—The works commanded a million acres; they have actually been distributed to about 500,000.

Do you know what those works cost?—Under £500,000; the last statement that I have is £420,000; there has been something spent since. There was no interest on money during construction included in that.

And what was the revenue derived from those works according to your last account?—The average revenue of the district from 1836 to 1846 was £196,000. The average annual revenue from 1867 to 1871 was £476,000. The average from the beginning to the year 1871 was £343,000. Taking the former average, £196,000, there was an increase of £147,000. The total increase in the twenty-five years was £3,670,000 (I am speaking now merely of the actual increase of the

revenue of the district: how much of that is applicable to the water is a separate question). Deducting 3 per cent. on the capital for twenty-five years, namely, £370,000 for repairs, it leaves a total nett increase of £3,300,000.

Is that 3 per cent. an estimated sum or an actual expenditure?—That is about the actual cost, I think it is rather under.

Was there any water-rate charged for the water?—The water-rate charged is four rupees for an acre of rice.

Is that four rupees an acre included in the income that you have spoken of?—Yes, it is all in there.

Have you got the amount of the water-rate separate from the general increase of revenue?—No; but it is about £200,000, because the acreage is about 500,000 acres.

Can you explain why the other half million of acres have not availed themselves of the water supply?—Because the money for the execution of the works could not be obtained. Works of distribution were wanted, and the money could not be obtained for them. I had continual correspondence with former Secretaries of State and Lord Halifax, and it was always said that the money could not be found.

Do we rightly understand it, then, that there was water enough to irrigate half a million of acres more, that at a moderate expenditure of £50,000 works of distribution could have been made but were not made, and that therefore the water was not distributed?—Yes. May I add that now they have ordered £100,000 towards the completion of the works. To show what portion of that total may fairly be considered due to the works, I have the two districts, Godavery and Kistna as they are now called, they were formerly called by other names.

That is the delta of the Kistna you mean?—The delta of the Kistna and of the Godavery, the works are exactly similar. The revenue in 1843–44 was £440,000, the revenue in 1870–71 was £1,040,000. The increase was £600,000, or 136 per cent. upon the revenue, not upon the works, the income is calculated in the same way as it is for the Godavery Delta—the total revenue.

That the water-rate was the same also?—Yes, the same water-rate. For six districts with less extensive irrigation and no railways, the revenue in 1843–44 was £1,280,000, in 1870–71 it was £2,080,000—an increase of £800,000 (these figures are all taken from papers obtained from the Statistical Department in the India Office)—an increase of 62 per cent.

Were those districts of a similar character, that is to say, delta districts?—Some of them were delta districts and some were not.

But were those that were not delta districts flat alluvial districts, capable of natural irrigation?—They are all capable of irrigation, and all are partially irrigated. Almost all the cultivated lands in the Madras Presidency can be irrigated, but the upper districts at a greater cost.

What I understand is, that you have given us the whole increase of the revenue of the district, and that you have given us separately the actual sum earned by the water-rate of the district?—No, I have

not given the sum earned by the water-rate; merely the difference of total revenue.

But, as regards the Godavery Delta, you gave us the sum received from water-rates?—Yes, in a rough way; but these are actual statements.

Do I rightly understand you, that you consider the difference between the actual receipt from the water-rate, and the whole increase of the revenue, as representing what may be called the general improvement of the district, in consequence of irrigation?—Yes. I am comparing it now with the other districts, to show how much is owing to that cause

Then you cannot separate what is the direct return from the irrigation, from the general improvement of the district, since the irrigation?—No, what I am doing now is comparing the progress of the highly irrigated districts with the more moderately irrigated, and with those that have the least irrigation.

Will you go on with your comparison, if you please?—Taking the remaining districts, seven districts, the revenue in 1843–44 was £1,620,000, and in 1870–71 it was £2,060,000, the increase of £440,000, or 27 per cent. From that I judge of how far the increase in those districts has been dependent upon improved irrigation. I must add this, that in those districts which have increased only 27 per cent. against 136 per cent. at least half of that increase is owing to improved irrigation, because there has been great progress in the irrigation in every district In seven districts an average of nearly £2,000,000 has been spent on railway works, where there was an increase of only 27 per cent.; that is, on the comparatively unirrigated districts, while on the irrigated districts, in which there have been no railways, there has been an increase of 136 per cent. The average revenue of Tanjore, Kistna, and Godavery is £600,000 a year; the revenue of all the other districts is £32,000,000; the number of districts, exclusive of some small ones, is about 150. The average of the unirrigated or partially irrigated districts is £210,000 The total population is about four and a half millions in the three irrigated districts, giving four rupees per head revenue. The population of the other districts is about 150 millions, giving two and a half rupees per head as the average of the revenue. What I wanted specially to point out is that I consider it the great financial fact of all India, that there are three districts yielding £600,000 a year, while the average of the other districts is £210,000, the sole cause being that those districts have been intelligently managed, and that the others have not

Do you ascribe any value to the circumstance, if it exists, that these irrigated districts are very fine alluvial lands, as compared with the general lands of India?—Yes, they are fine districts, small districts with a great extent of alluvial land, but I do not think that they are much superior to the other districts as to the total quantity of good available land.

Has it been brought under your notice whether the difference of the revenue goes to this extent, that the alluvial fields and small tracts that are irrigated by a natural flow pay a revenue as much as 50 and

60 rupees an acre, as compared with districts that are not so used, which pay only perhaps a quarter of a rupee an acre?—I never heard of any tracts that paid 50 rupees an acre.

Did you never hear of what are called natural wet lands, upon which sugar crops are grown?—Yes, but never paying anything like 50 rupees an acre. Now, in all the financial papers that I have seen not one has alluded to this most striking fact of the enormous revenue raised from three particular districts.

IS IRRIGATION APPLICABLE IN EVERY DISTRICT IN INDIA?

(Examination by Sir S. Northcote, late Secretary of State for India.)

Now this system of irrigation has been productive of very great benefit in certain districts, but do you think that it is equally applicable to other portions of India as it is to the deltas of great rivers?—To every district in India; but not with equal benefit, because some districts would be more expensive to irrigate than others, but it is equally applicable.

Do you believe that it could always be made self-supporting in those parts of India where famines occasionally occur?—Much more than self-supporting.

Are you aware that in Orissa it was exceedingly difficult to get the people to take the water?—Yes.

How do you account for that?—What Colonel Rundel writes to me on that subject is, that the amazing difference of the race he had to deal with there, their great inferiority to our races in Madras, had thrown him out of all his expectations; that he could not have believed they would have been so stupid and backward to use the water as compared with what he had been accustomed to in Madras.

Does that shake your faith in the universal applicability of the irrigation system?—Not in the least. I am quite certain that that difficulty can be overcome by active intelligent men, laying themselves out for it.

Do you happen to know that in Orissa, at a time when it was thought very desirable to get the people to use the water, an official gave what was construed into a promise that the land revenue should not be increased to those who took the water, do you remember that particular case?—This was one of the difficulties, the people could not trust the Government; they were afraid that if they charged them $2\frac{1}{2}$ rupees for water-rates they would then increase the land-tax besides; and what they wanted was a clear, downright, unquestionable assurance that it would not be done, and that was not given, and that was the difficulty.

Now do you believe that the real remedy for drought and failures of crops in India is to be found in the extension of irrigation works all over the country, rather than in the improvement of communications to enable the surplus of one part of the country to be brought to another part where it is wanted?—Not rather than, but combined with improvement of communications

No doubt it would be extremely valuable, if you had money enough

to carry out both these systems; but supposing that your funds are not sufficient to do both, which do you think the more important?—I am speaking of combining navigation and irrigation, and you cannot have the one without having the other.

But I am comparing the extension of railways, and roads, and other modes of communication, so as to enable you to bring the surplus of one part of India to the part which may happen to be deficient, with a system which is to provide locally for the wants of every district, so as to ensure it against the effects of a casual drought?—What we want is a complete system of water-communication, from one end of India to the other.

But would you say that you could supersede a line like the East Indian Railway by a system of canals?—Entirely, and totally supersede it. May I be allowed to give an explanation of that? I can cut a canal from Delhi to Calcutta for £3,000 a mile against £20,000 which the railways cost, when it is done it will carry millions of tons at one-tenth of a penny a mile against 100,000 or 200,000 tons carried at 2*d.* a ton a mile by the railway; and the canal will carry that traffic at any speed that you want to work it. Where is the advantage of the railway? This is my view of the matter.

Now going back to the comparison of Madras with other parts of India, how frequently do the people require in those districts in Madras to use the water, do they require it every year?—Yes, certainly.

There is not a sufficient rainfall to enable them to carry on their cultivation properly without the use of artificial irrigation?—Not a want of sufficient rainfall, that is not the point, it is a want of sufficiently regular rainfall. In the great famine of Orissa there was a fall of 60 inches of rain that year, there may be 40 inches of rain in Rajahmundry, and the whole harvest be lost without irrigation.

What I am anxious to know is whether there are not some parts of India in which you may make the irrigation profitable, because the people will regularly rely upon it knowing that taking year with year they will always require to use the water, whereas there are other parts in which perhaps five years out of six, or nine out of ten, they do not require artificial water, the rainfall being adequate and not more than adequate; but in perhaps the sixth year or the tenth year they require it?—There are no such districts in India. There never was a year in which water was not required in Orissa, I am perfectly sure of that. At some part of the season, there is as I say 50 or 60 inches of rain; but that is not the point; the point is whether there is such a long interval as that the crops may be either seriously injured or totally lost.

DO ALL MADRAS WORKS PAY WELL?

(Cross-examination by Mr. Fawcett)

All the irrigation works, even in Madras, have not produced these satisfactory financial results to which you have alluded, have they?—Every one that has been carried out at all

But should you say that the financial results and the financial

prospects of the Madras Irrigation Company's schemes were encouraging?—Fully so; perfectly satisfactory.

Can you give the returns at the present time?—They are not in operation.

But are they ever likely to be in operation?—There is nothing to prevent. They were used to a certain extent last year; there is nothing to prevent their being extensively used this year.

You are aware that competent engineers have expressed an opposite opinion?—I have never heard that.

You never heard an opinion expressed that the canal will not hold the water?—What can I say to an opinion of that sort when it was actually flowing all last year and held water perfectly well?

If it was flowing all last year and held water perfectly well, how do you account for the canal yielding nothing at all?—It was used to a certain extent, last year, and there is every prospect of its yielding a large revenue this year.

You are aware that the canal has cost greatly more than the estimate?—Yes; some 50 per cent. more than it was originally estimated to cost.

Are you aware that its prospects were looked upon by the general commercial world as so gloomy that the company could not raise the requisite money to complete it, but that the Government were obliged to advance £600,000 on what they considered most inadequate security?—I have had fifty years' experience in these matters, and know perfectly well that the gloomy opinions were without foundation.

How is it, then, that, with all the intercourse you must have had with them, you have never been able to produce the slightest impression upon the large capitalists in England, and never got them to invest one shilling in these brilliant works, but always have been obliged to sing the same song, "Government, Government, Government?"—I have done neither the one nor the other, I have nothing to do with commercial men.

But you must admit that the estimates as to the cost of these Madras irrigation works are altogether fallacious?—They have cost more than they were originally estimated to cost, and, in the first place, it is impossible for works taking ten years to execute not to increase in cost.

You say that you made repeated applications to Secretaries of State to finish the works to which you first alluded, in the delta of the Godavery?—Yes.

Of course we have a right to assume, that Secretaries of State have no particular reason for preferring railways to irrigation works; they must have given you some reason why they thought it was undesirable to advance this additional sum of money?—They never gave me any reason at all.

Did they never publish any reason?—Never. There are the facts; the railways are universally a failure in point of return; here are the irrigation works, every one completed is making a good return. Those are actual facts; nobody can mistake them.

Those you have mentioned are; but I think if we were to go through the irrigation works throughout India, we should find that

some of them did not yield more satisfactory results, or as satifactory results as some of the railways?—There is no such thing as a railway which has returned anything like what the worst of the navigation works has.

I am not in favour of railways; but the East Indian Railway nearly pays 5 per cent., does it not?—According to the way in which they make out the accounts, the actual returns last year were 4½ per cent., and there is a debt upon it of £17,000,000. They did not pay interest in one-half year or two half-years. Not paying interest on the debt, and not paying interest on the cost of the land, there was an insignificant surplus above the 5 per cent.

What your statement about the general profitableness of irrigation works means is this, that if all the irrigation works in India had been properly constructed with good economy, and there had been no mismanagement, they would all have yielded a very satisfactory return?—No; I say that all those in extensive operation at this moment are yielding a fair or a very large interest.

NAVIGATION CANALS FOR ALL INDIA.

(Examination by Mr. Dickinson.)

The system of river and canal irrigation and transit is only applicable to the valleys down which the rivers flow?—Yes

You could not adapt the canal navigation to carry across from valley to valley, across the line of rivers?—On every important line of country in India you can carry a canal, that is to say, on every line where there is great population.

Take the flow of rivers beginning at the north, the great rivers flowing east and west; take the Ganges valley, there you would accommodate the whole of the Ganges valley by canals?—Certainly.

Coming south from that could you make a water navigation?—The whole of the way, all along near the coast from Calcutta, by Cape Comorin up to Goa, is all perfectly easy for navigation.

From the Deccan southward the rivers flow east?—Yes.

Your traffic would all be to the Coromandel coast?—Not the whole, because I would make cross canals across the peninsula.

Would you take the waters which now flow east, westwards through the ghats?—I would make the canals across; some of the water in the canals would flow east and some west; I would supply them at their highest level, of course. There is one line from the west coast at Ponany to Madras, for instance, through the opening in the ghats there which is perfectly practicable.

Between Travancore and Mysore, you mean?—South of Mysore.

And, in your opinion, would canal navigation meet the whole transit wants of India, of its commerce, and its people?—Perfectly and entirely, without any one defect whatever.

What would be your communication, for instance, from Madras to Bombay how would you get from Madras to Bombay?—I do not mean to say that every line in India can be traversed by a canal, but every line on which it is of great importance that there should

be transit. There may be minor tracts like some part of the line between Bombay and Madras which might be better for railways. I mentioned that there is nothing to prevent a canal across the peninsula from Madras to Ponany. There is another line perfectly practicable by Dharwar, from the east coast to the west, at the port of Carwar; there is nothing to prevent that being a water communication

Is that something of the line of the proposed railroad?—Well, they are talking of railroads everywhere, there is another line again from Coconada right across the peninsula, following the line of the Godavery, the Wurdah, and the Taptee, also perfectly practicable for a complete navigation.

And that scheme would unite the waters of the Godavery or the Wurdah, flowing east, with those of the Taptee, flowing west?—Yes; a complete line from Bombay up the valley of the Indus, down the valley of the Ganges, along the east coast, to Cape Comerin, up the west coast to Goa, and across from Madras to Ponany, from Madras to Carwar, and from Coconada to the mouth of the Taptee would form a complete scheme of navigation for all India.

The mouth of the Taptee at Surat?—Yes.

In your long investigation of the adaptation of canals to India, I suppose you have considered the matter as a scheme for the whole country?—Yes.

Have you done anything of the same kind as regards other channels of communication besides water?—No. May I give the reason? Because nothing else can possibly answer the purpose; there is no other conveyance that will carry goods at a tenth or a twentieth of a penny a ton a mile, and no country can thrive till it has got cheap transit

And you consider that there is water enough in India to feed all these canals?—There is water enough in India for every conceivable purpose ten times over; there is no want of water.

Have you any scheme for connecting the upper waters of the Jumna with the Indus, or the Ganges with the Indus across the deserts?—They are cutting it now, the Sirhind Canal.

That is the bed of an old canal, is it not?—No; the main canal is one entire new line, there are some remains of old canals in that part of the country.

What is that new canal to join?—The Sutlej with the Jumna.

As regards passenger traffic, I presume the canal would not be a very rapid mode of transit?—I know of no limit to the navigation of canals, and I am sure there is none.

As regards speed?—In speed. I am quite sure that a boat can be navigated at the speed you choose to give it on a canal.

With any quantity of coal, that is to say?—Within practicable cost and everything, in a practicable way, I mean. The speed on the railways in India at this moment is only, I believe, twenty miles an hour, on some lines twenty-five.

Is there any passenger traffic now on the Ganges Canal?—I do not know, I have not particular returns, but I made out by the last partial returns I saw that there is about 100,000 tons of goods

traversing it now, but our canals on the Godavery are crowded with passengers, the whole travelling of the district is by the canal.

Do you consider that the East Indian line of railway is in a sense competing with the Ganges Canal—that as a line of communication it competes with the Ganges Canal?—So far as I have returns, I fully expect that the goods traffic on the Ganges Canal is greater than on the railway that runs by the side of it.

That they are seeking for the traffic of the same line of country, and therefore in competition with each other?—Yes.

And do you consider in that sense that it would have been better to have a railway where there is no water competition, than to have it over a line of country where the rivers furnish water communication?—Certainly, if you are to have a railway, have it where there is no water carriage.

But you seem to go as far as to say, that water carriage will meet all the requirements of India?—Every requirement of speed, cost, quantity, and everything.

And the cross traffic of the country?—Everything; I do not mean to say that there are not particular lines on which railways might be made, supplemental lines, but those are quite secondary, very inferior cases

Can you explain to the Committee why the people use the East India Railway to such an extent as to give it a 5 per cent. dividend, when they are perfectly free to use the Ganges?—Because the Ganges river has such a very imperfect navigation, and because the railway is backed up by £700,000 a year paid out of the revenue.

That £700,000 does not give it the traffic?—That is what enables them to carry cheap; if that £700,000 was divided over the traffic it would bring it down directly.

But the question put to you was, did the traffic on the East Indian Railway return an income of nearly 5 per cent.?—The return last year, without allowing for the price of land, was 4½ per cent., and, including the price of land, 4¼ per cent., leaving a debt of £8,500,000, the interest of which is paid out of taxes.

When you talk of the cost of land, do you mean the cost of land as sold in the market, or the value of that land as still continuing to earn revenue to the Government?—I take the cost of it in the Blue Book, I have no other authority. I omitted to say that there are about six essential mistakes which have been made in the navigation of the Ganges Canal. I will not go into the particulars, but to give you an idea of the extraordinary mistakes that there were I will give you one: not one of the bridges would allow a fully loaded boat to go under it; they are at this moment raising fifty bridges to allow the traffic to pass under; that is only one out of six essential mistakes in the navigation, and in spite of that this traffic of 100,000 tons has sprung up.

They are now raising the bridges to meet the traffic, as I understand you?—They have raised about half of them, and they are raising the others.

Was that the fault of those who made the canals, or those who

made the roads, insisting on low gradients?—I think the mistake was in the projection of the canals.

I think you said that the speed in a canal was twenty miles an hour; the only limit being, I suppose, the injury to the banks?—There is no such thing as injury to the banks, it is entirely imaginary; they talk of little canals here, not made for steam, 30 or 40 feet broad, without one foot of land to spare; we have no such thing in the great canals in India, which are fitted for steam; if you talked of an objection to railways because horse railways would not bear locomotives, it would be a similar case, I am talking of canals made for steam.

What widths do you speak of?—The great irrigation canals are from 30 to 100 yards broad.

Whilst you are speaking of the Ganges let me ask you this: is not one reason why the canal is not usable for navigation that the water has been taken from a high level, in consequence of which the fall is too great?—Yes; that is one of the essential mistakes that was made; so great a fall was given that the current was so strong as to cut the banks and bed of the canal.

In consequence of which it rendered it almost unnavigable?—It injured the navigation.

Are they not about to remedy that mistake?—They have been at work at it for two or three years.

And when that is completed, do you consider that the traffic in passengers will be very much increased?—I suppose it will.

Now, in the course of the evidence, we have heard something about the interference with the old system of wells by the introduction of canal water as being somewhat oppressive to the owners of wells. What do you say to that?—There are two points in the comparison of canal-irrigation with well-irrigation. The first is that it costs from one-tenth to one-fiftieth part of the money to water from canals; the other is that the river water is so entirely renovating that the lands watered by it yield crops for hundreds of years without any manure: whereas well-water is filtered, and does not manure at all, or except in a very small degree.

Now, in a military point of view, would not that line of railway be easily destroyed?—Yes, it would be destroyed immediately if there was any disturbance within hundreds of miles of it. My great point is this: that what India wants is water carriage; railways cannot carry at the price required, and they cost the country £3,000,000 a year, and increasing, to support them, that steamboat canals would not have cost more than one-eighth that of the railways; would carry any quantities at nominal prices, and at any speed; would require no support from the Treasury, and would be combined with irrigation; and that this water carriage is now absolutely necessary, as if no railways existed, to enable the country to prosper.—(Extracts from Evidence taken before the Committee on E. I. Finance, July, 1872.)

THE MARCH OF GOVERNMENT TO BANKRUPTCY.

CROSS-EXAMINATION OF GEN. R. STRATCHEY, R.E., PUBLIC WORKS SECRETARY, BEFORE THE PARLIAMENTARY SELECT COMMITTEE, 1872

(Examination by Mr. Smith, M.P., Stockport, Manchester.)

It appears from the reports on railways in India that the capital expended up to March, 1870, amounts to 91 millions, in addition to that, there is 4 millions loss on exchange, then, in addition to that, railways have cost 7 millions for land, and in addition to that, there has been paid for interest upon the capital beyond the traffic receipts a sum amounting to 17 millions; making a total of £119,695,000. Now we will take that in round numbers the railways have cost the Government 120 millions, and I see by the returns that the nett receipts amounted for the year 1870 to £2,846,000. If you take it in round numbers you have this—the interest on the railways amounts to £6,000,000, and the receipts amount to £3,000,000, so that there is a loss of £3,000,000 per annum upon the existing railways; and I have got the return now for 1871, and I see that the receipts are rather less than they were the previous year?—Well, the general state of things that you have described, no doubt, is correct

In the face of these facts, are the Government about to make new railways for the purposes of developing the resources of the country, or are they merely for political objects?—Both.

Which are those which are for the development of the resources of the country?—The only two lines that are being carried out for political objects are those in the Punjaub and Scinde, the Indus Valley line, and the line from Lahore towards Peshawur.

Those are the largest lines, and will involve the largest expenditure? —No, not altogether; one of them, the line from Lahore towards Peshawur, is extremely expensive on account of the bridges.

What would be the cost of that?—I am not prepared to say offhand; it will cost about £10,000 a mile.

The proposed expenditure on State lines is £12,000,000?—I do not know anything about these figures.

Now, have you any expectation that these lines in Scinde, which you are projecting, will be more profitable than the existing lines in Scinde?—The belief is that the line from Moultan to Kotri will lead to a charge on the revenues, after setting off the nett revenue against the interest of £30,000 or £40,000 a year.

You are aware that, according to the report here, the present expenditure on the Scinde railways amounts to £12,000,000?—I dare say.

And that the Government have paid upon this outlay interest of about £3,100,000?—Yes.

So that the cost of the railway is £15,100,000; now, are you aware that the income in the last year was only £86,402, which amounts to

11*s*. 6*d*. per cent. per annum upon the outlay?—The Scinde, Punjaub, and Delhi concerns, no doubt, are the worst of the whole lot.

But do you think that the Government can go on in this way, unless they make up their minds to march to bankruptcy?—When the Government undertook these railways, it made up its mind to spend money upon them, and it made up its mind to spend money year by year out of the revenues of the country.

Is it not necessary for the Government, before they enter into new speculations of this kind, to look at what the past has done?—Most surely and certainly, and they have done so.

Do you think that it is desirable, in the present state of the Indian finances, for the Government to engage in further outlay which is unproductive?—I think that it may be judicious. I do not think that it necessarily is injudicious. I think that all such expenditure requires great caution.

But is there any prospect of the Government revenue increasing to such an extent as to enable them to meet new losses upon unproductive works?—I think there is. I have every reason to think it.

How do you propose to meet the deficiency in the revenue?—By prudence and economy generally.

If they be ever so prudent, supposing the opium revenue, for instance, which last year produced £8,000,000, should fall to £6,000,000, what must the result be?—I do not admit that the Indian revenue is extremely liable to great fluctuations, which cannot be foreseen.

You do not dispute the facts of these fluctuations in the revenue?—Not the least.

I have in my hand the financial statement for 1872-73, in which the estimate is a surplus of £237,000; do you think with such a surplus as that the Government are justified in entering into large engagements which involve borrowing money for unproductive works?—I do not see why they should not be. I do not see that necessarily on an estimate of that sort it would be imprudent to go on with the construction of works from borrowed money in the way that the Government of India has been doing.

There is great dissatisfaction in India at present on account of the income tax?—We will suppose that that dissatisfaction might induce the Government to abolish the income tax, but would it not be impossible to do so with a large increase of expenditure on account of borrowed money for public works, which will not pay?—Well, it is obvious that if the charge for debt goes on increasing without any corresponding increase of the revenues, it is impossible to abolish existing sources of revenue; that stands to reason.

I want to call your attention to the Scinde, Punjab, and Delhi Railway again. You were recommending a large outlay in that country; and at our last sitting I called your attention to the last report of the Railway Department, showing that that railway had only produced 11*s*. 6*d*. per cent. per annum?—The nett return is very small, although the gross receipts are satisfactory.

What we are to look at is the nett result?—But I was explaining that the conditions of the different portions of the line which goes by that name are extremely different. Between Moultan and Lahore

the country is very nearly a desert, and there is a very little population.

What traffic do you expect from that desert?—I never expected any good results from that line that I am aware of, and we never had any; the line was not made on my recommendation. Between Lahore and Delhi, which is another part of the line, and under totally different circumstances, the country that is traversed is reasonably fertile and well cultivated and peopled; but unfortunately it passes through an extremely difficult country, being traversed by the drainage from the mountains on the north

How do you propose to provide for the payment of these railways; would you borrow money to make railways which are certain to prove unproductive?—That is the only way to make a railway; it is quite impossible to make them out of revenue.

Then you would go on making unproductive railways, and take the chance of the revenue being sufficient to support it?—Certainly not. I have distinctly stated that I strongly object to making unproductive railways. You must separate me, if you please, from the actual policy which the Government of India has adopted.

(Examination by the Hon. Chairman.)

Do you know whether an accurate estimate was made of the probable out-turns of the projected new State railways before they were sanctioned?—As far as it is possible to make such an estimate, yes.

And do you know whether the estimate is that they would be profitable?—The Government of India considered what was the return which was actually received from existing railways passing through a country, as nearly as could be judged, similarly circumstanced; and they say then, taking a moderate view of the probabilities of the traffic, and deliberately taking a moderate estimate, we may fairly anticipate a return of so much a mile on this projected line of railway. That I look upon as the only possible means of estimating the traffic of the railway.

I wish to call your attention to a telegram from the Viceroy to the Secretary of State, sent on the 8th of May, 1872: "Nett revenue on outlay from loan-funds on State railways under construction estimated as follows: Lahore, Jhelum, 100 miles, 2 per cent., Rajpootana system, 300 miles, 4 per cent; Holkar line, 86 miles, 3 per cent.; Wurdah Valley coal branch, 50 miles, 5 per cent.; Patree salt branch, 22 miles, 4 per cent., Indus Valley, 500 miles, 3 per cent., can you explain anything connected with this, as it occurred in 1869, when you were in the Public Works Department?—I know that quite recently the Secretary of State has received from the Government of India approximate estimates, preliminary estimates of the probable cost of completing the line from Mooltan to Kotri, and the probable income, and that on that they conclude that there will result an actual loss.

What is the probable amount?—I forget the precise sum; £20,000 or £30,000 a year, I think; that is, that the Government will have to pay for the advantage of having this line of railway from Lahore to the sea, £20,000 or £30,000 a year.

Then in point of fact the estimate that was formerly made of 3 per cent. profit now degenerates into an estimate of a loss from the working expenses being in excess of the receipts ?—All that I can say is that I know nothing whatever about that estimate contained in that telegram, and I do not, at the present moment, understand how any such figures could have been sent, or how they are arrived at. The Government of India (I do not say that they are wrong, but only that I differ from them) have considered that the opening out of railway communication between the Punjab and Kurrachee is a political object of great importance, and they think that it is worth while to pay the £20,000 or £40,000, or whatever it may be, a year to attain that object. . . . The traffic between Kotri and Kurrachee is exclusively the through traffic between the Indus and the port of Kurrachee; the country between Kurrachee and Kotri is a desert, with no population, no town, nothing except sand and stones. If I desired to spend more money upon railways, that is not the one which I should undertake.

Upon what principle do you think that the expenditure upon any railways as State railways should be regulated; upon what principle should the selection be made of lines to be undertaken by the Government ?—Well, the question of general policy is one important question, what is required for the military defence of the country is another important question; the requirements of export commerce are another important matter; and the requirements of a large population locally are; the internal communications and trade of the country are also important matters, and all these complicated considerations every one who attempts to form a judgment as to the expediency or not of making a railway has to weigh and arrive at a conclusion in the best way that he can.

It appears from the report of Mr. Danvers, that £12,000,000 is the first estimate of expenditure on new lines, and out of that £12,000,000 £3,000,000 was to be spent in the Punjaub Northern, from Lahore to Peshawur, and £5,000,000 in the Indus valley, from Moultan to Kotri, making £8,000,000 out of the whole £12,000,000; that £8,000,000 would seem to be spent in a district which has hitherto proved extremely disastrous to railway profit, do you understand that that expenditure has originated, or that this proposed expenditure of £8,000,000 has originated mainly with the Government of India or with the Secretary of State ?—Well, there is no doubt that the initiative in this case has been taken by the Government of India. The obligation, so to speak, for undertaking the line from Lahore to Peshawur is purely and simply a military obligation. That applies to the extension of the railway from Lahore to Peshawur. The line between Moultan and Kotri is very much in the same category, and the Government of India, in writing to the Secretary of State on the subject, say that they do not think that it is a heavy charge on the revenues of India to provide railway communication at an expense, as far as my memory serves me, of £30,000 or £40,000 a year, that is the nett loss that will accrue after setting off the nett profits against the interest. The whole of the other lines that are going on stand upon a totally different footing. The first of the State lines that I should refer to is the line from Agra to Ajmere; in the vicinity of

Ajmere is a salt lake, the salt made at which is the principal source of supply of salt for the North-western Provinces and Oude The principal motive of the Government in undertaking this railway at the present time has been the feeling that, until a very greatly improved means of transport has been provided between the salt-producing districts and the salt-consuming districts of that part of India, the population, generally speaking, will have to pay very much higher prices for salt than is desirable, and that the actual supply which they can receive will be very much less than is required for their convenience, or even for their health.

The scheme that you have just been describing is the scheme for the 369 miles of railway, which is to cost 2½ millions, called the Rajpootana line?—Yes.

(Examination by Mr. Fawcett.)

I understand the drift of your evidence to be this, that State railways in India are to be divided into two classes, one of which you may describe as commercial railways, and the other as military railways, though necessary for strategetical purposes; is not that the case?—I think it would rather be that you may divide the railways into two categories.

If a railway is made chiefly for military purposes, and is to be looked upon as involving military expenditure, is it not a stretch of language to describe that as a reproductive work, which ought to be made out of borrowed money?—From the very nature of such undertakings, it is absolutely impossible to construct them unless with borrowed money.

My only object was to show that some works which are classed as reproductive are railways which are carried out chiefly for military purposes?—Quite so; and they are classed among other works of the same decription, for convenience, though some of them are not remunerative, and only reproductive in a limited sense.

THE DUKE OF ARGYLL ON MILITARY RAILWAYS.

Looking at the great questions of policy involved from these two opposite points of view (narrow and broad gauges), I have no hesitation in saying, in the first place, that under the present circumstances of India the military argument must be considered as secondary to the economic. *The danger to our Indian empire from financial embarrassment is a far more real and a more pressing danger than the danger of sudden invasion on the North-west frontier by a great military Power.*

Even supposing this particular danger of invasion to be greater than I conceive it to be, it is a danger which has already to a great extent been met. Continuous lines of railway, on the standard gauge, have now been completed, which

connect Lahore, the capital of our most northern province, with Calcutta on the one side, and with Bombay on the other side of India. As much, therefore, of the rolling stock of all the lines now completed as can be used upon a single line of rail is now available for the concentration of troops upon the Punjaub.

It is true that the communication with Bombay by Allahabad and the Jubbulpore Junction is circuitous, as compared with a line down the valley of the Indus, but at the moderate speed of fifteen miles an hour, Lahore is now within little more than a hundred hours from either Calcutta or Bombay.

It may be fairly argued that even as against a great military invasion of India, of which a few months' or even a few weeks' notice could be had, the narrow-gauge lines would afford most important facilities.—(Extracts from a Despatch to the Government of India, October, 1870, P. R. 156, 1871, p. 31.)

THE DUKE OF ARGYLL'S DECISION.

Our first choice ought to fall upon irrigation rather than upon railways, and that so much as may be necessary of the funds at our present and prospective disposal should be devoted to the improvement and re-establishment of the ancient system of irrigation, before any outlay is applied to the construction of a railway.—(Mysore Railway: extract from Railway Report, 1873, p. 51.)

ESTIMATES AND PLANS OF CANALS FOR ALL INDIA.

COMBINED IRRIGATION AND NAVIGATION CANALS FOR ALL INDIA.

(By Sir Arthur Cotton, R.E., K.G.S.I.)

INTRODUCTION.

Whether we consider this question as simply connected with the lives of millions, or as involving our character in their eyes from the mode in which we deal with it, either in leaving them to perish, or showing sympathy, wisdom, and energy in endeavouring to save them—whether we look upon it as a matter of duty or of interest—the terrible importance of the subject is beyond calculation. The famines are periodical, recurring at such frequent intervals that they are, in the fullest sense of the word, a standing subject in the management of India. They occur in some parts of India perhaps every ten years, and we may therefore consider their return in future a certain event, and at least as much to be provided for as war, or any other of the matters for which Government is instituted. The remedies which I propose for it are works in which I have been actually employed for forty-five years, during which I have had more or less to do in projecting and executing various great systems of works, irrigating millions of acres, so that I shall not have to discuss anything about which I am not really conversant.

CAUSE OF FAMINES, NOT WANT OF WATER, BUT MEANS OF DISTRIBUTION.

Some people account for the cause of famines by saying "it is want of water." But this is directly false: it is not owing to the want of water. There is no want of water in India. The sole cause of the famines is the want of such a sense of duty as will compel those who are in authority to use the proper means to prevent them. When Guntoor lost 200,000 by famine, a

river was flowing through it which never fails, and which in a single day carries to the sea four thousand millions of yards of water; and as six thousand cubic yards will secure a crop of rice on an acre, water enough was running to waste in one day, in that one river, and in that very district, to secure 700,000 acres of rice, the food of two and a half millions of people for a year! A single day's water would thus provide food for five times the whole population of that district. The sole cause of the famine was that the water was not distributed over the land.

So with the Orissa famine, in the centre of it, where the people died by many thousands per week, not only was there a river passing through it, while the harvest was perishing, which would have provided water in one day to secure food for one and a half or two millions for a year, but there actually fell sixty inches of rain in the district itself—twice as much as the average of England. If it is asked, How could the harvest fail, then? the answer is, that the local rain was of itself sufficient to give 7,000 cubic yards per acre—more than enough for such a crop of rice—but that it fell in such untimely quantities, with such long intervals, that the crop withered between the falls.

TWO EFFECTUAL REMEDIES TO PREVENT FAMINES.

This is a most important point to be considered. In India the rain often comes in such violent bursts, with such a continuance of cloudless weeks between, that the crop withers before a second fall occurs. In the Carnatic, where we have forty inches of rain, I have known ten inches fall in a night, and a fortnight after, twelve inches in twenty-four hours, equal to a whole year's rain in Norfolk thus falling in two showers.

It is these two things, the local rains sometimes failing over a certain tract, and when there is no deficiency that it sometimes falls in such untimely bursts, that form the great peculiarity of the Indian climate. There is never a want of water in India on the whole: the worst year that ever occurred, there was water enough flowing into the sea to provide food for the population at least twenty times over. Thus this excuse for letting our fellow-subjects die by millions is disposed of for ever. Only one thing is wanted—that the supply of water should be regulated by artificial means: 1st, that the water should be led from the rivers upon the lands by canals; and

2ndly, that the violent bursts of rain should be stored in tanks, from which it can be drawn off as it is wanted. These are the two grand means. Both of them have been extensively used by the natives from time immemorial in some parts of India, with great engineering skill and with admirable effect.

The one remedy therefore is, and must be, water for irrigation, and water for navigation. This, so far as it is provided, will certainly, under the circumstances hitherto found in India, prevent famines; that is to say, no famine has occurred since we have been in India, in which, if we had used the means within our power, the calamity would not have been so far modified as to be a mere shadow of what they have always been, and are at this moment. If God indeed is pleased to withhold the rains beyond anything yet experienced, so that the great rivers fail, or to give them in such unprecedented excessive quantities that our embankments are destroyed, and our drainage works insufficient, famine would still occur; but then, so far as such works were concerned, we should have done our duty.

QUANTITY OF WATER REQUIRED FOR DIFFERENT CROPS.

There are two kinds of crop in India, viz., 1st, rice, which requires to be kept constantly flooded, and takes about six thousand cubic yards of water per acre for a six months' crop (for there are varieties that are from four to seven months in the ground), and, 2nd, what we call dry crops, such as wheat, millet, cotton, &c., which require only to be moistened, for which from one thousand to one thousand five hundred cubic yards are sufficient. Again, as irrigation makes us independent, in a great measure, of local rains, the whole year is available for cultivation, and there is nothing to prevent two crops a year, and even three of some kinds of produce.

In India we have always a powerful sun, and where that is the case nothing is wanted but any kind of practicable soil and water. The poorest soil will produce good crops there, if it is irrigated. Nothing is more striking in India than to travel in a burning land-wind in April or May for scores of miles without seeing a green blade, and then coming suddenly upon a tract under one of the large tanks or channels that contain water all the year, and to find yourself in a moment in the midst of the richest possible vegetation of fruits and grains of every kind, the latter in every stage from sowing to harvest.

SUPPLY OF DRINKING-WATER.

The importance of irrigation merely as supplying water for drinking is also incalculable. A large proportion of India is in a wretched state, from the want of pure drinking-water in the hot season. In multitudes of places people drink brackish and mineralised water, or go miles for drinkable water, or drink the bottoms of village tanks, which have been evaporating for six months, and have only a few inches of the filthiest water remaining in them.

NECESSITY OF DRAINAGE.

Consider the regulation of the water with regard to health. For several years past, a great extent of country round Calcutta has been desolated by fever of such a nature that numbers of villages have been almost emptied by it, tens of thousands having died of it. It seems to have been entirely owing to the want of drainage in the monsoon, and the want of good water to drink in the dry season. It is impossible to conceive the state of those villages in those dead alluvial plains: in the monsoon without a foot of dry ground, and surrounded by pools of water. And in the dry season not a drop of wholesome water to drink—nothing but the remains of these pools a few inches deep, in which filth has been accumulating for months. Compare this with the state of an irrigated tract completely pervaded by drainage channels to carry off the waters in the monsoon, and canals of running water, fresh from the river, flowing through every village. When I speak of the land being irrigated, I include all drainage and other works for the complete regulation of the water, and for navigation also.

THE LESSON FROM NATIVE WORKS OF IRRIGATION.

These works were of two classes: first, weirs and canals to lead the water from the rivers, as it is led in England, to turn mills; and secondly, tanks, so called, but in reality artificial lakes, formed by throwing embankments across valleys to store up water. Of both these there are numerous works: indeed there are many thousands constructed by the natives, and it is from these entirely that we have learned to plan those immeasurably valuable works; but it is only in certain parts of India that these old works exist: by far the greater part of the country is entirely without them. Many of these works are

essentially defective, in being wholly dependent on the local rains, so that when these greatly fail, they are useless. They effectually regulate the water in those seasons where there are violent bursts of rain, and intervals so long as to ruin the crops which have not their help; but they cannot supply the want of local rains, as the works do which are connected with the great rivers, which never fail. Still, these native works have been of inestimable benefit, and especially are they now, in pointing out to us what to do with our vastly superior advantages of extent of sway, capital, science, &c.

NATURAL FACILITIES FOR STORING WATER.

With respect to the sites for these, it is one of the remarkable features in the topography of India, that there are no lakes in it, excepting pieces of old beds of rivers, of which some parts of the basin of the Ganges are indeed full. There are no natural lakes of the ordinary kind, but there are extraordinary natural facilities for storing waters by closing gorges in lines of hills, where a very short embankment will form a basin of very great extent, and thus secure vast quantities of water. There is in fact no limit to what may be done in this way, and all the river irrigations should be supplemented with them, for though the main point will be gained by using the rivers in the monsoon, as they are all too low in the dry season, to secure any great extent of cultivation at that time, additional water must be obtained from tanks. Thus the Godavery supplies abundance of water to provide one and a half million cubic yards for about seven months. but about the end of the dry season the stream dwindles to about 300,000 cubic yards, and to keep up a supply of one million, which would, perhaps, be all that would be used at that time, would require about two thousand millions cubic yards.

WE COMMAND ALL THE WATERS IN INDIA.

It must always be remembered that the extent of our territorial possessions, and the complete establishment of our paramount power, have given us the command of all the water of India; so that although rains fail, and water may disappear in one part of the empire, we can always supply it from another, as the rains never fail everywhere; and as a matter of fact the great rivers of India, flowing from one side of the empire to the other, do frequently pass alternately between

districts exhibiting the extremes of drought, in parched barren deserts where the crops have failed, and districts covered with luxuriant vegetation, where abundant rains have fallen, so that our control of the water enables us to equalise the supply in different parts of the empire. In no country in the world was such an opportunity offered as this, of immeasurably benefiting so vast a population, at the same time that she promoted for herself benefits beyond all calculation, as by regulating the waters of India.

IRRIGATION AND NAVIGATION CANALS—FUNDAMENTAL PRINCIPLES.

The questions of irrigation and navigation in India are so intimately connected, that it is necessary to try and settle fundamental principles in both, before we can possibly form sound judgments respecting our future proceedings in this matter. Wherever irrigation on a large scale is carried on, we shall have noble steam-boat canals for navigation. To water a million acres of rice we require a canal 170 yards broad and 3 yards deep, flowing at $1\frac{3}{4}$ mile an hour; so that even if it were diverted into six branches, they would each form a first-class navigation. And if the fall of the country is such as to require occasional weirs to provide for a portion of it, it is only necessary to make a lock at each weir, to pass the boats round it, which is all the additional expense that the navigation causes. And over a vast extent of India the fall is so moderate that there need be no locks at all. Thus, from Hurdwar to Calcutta, 1,000 miles, there is only 1,000 feet of fall. What highway in the world could compare with this, whether for goods or passengers? Thus, in providing against famines we at the same time cover all India with a complete system of internal transit, at such a rate of freight as will give it an advantage over every other country.

AVERAGE COST £3,000 PER MILE.

1. The cost of the canal, 30 yards wide and 2 or 3 deep, would certainly not exceed £3,000 a mile.

2. It would be navigated by vessels of 250 tons.

3. It would convey at less than one-fourth the charge by the railway, both for goods and passengers.

4. On this canal everything would be carried at its own most

suitable speed, according to the value of the goods and the class of passengers, without any interference with the other traffic.

5. The highest speed would be the same as it is at present on the railways in India. Vessels could start from any point of the line, at any time, day or night, and could touch at any point on the whole line.

DATA FOR THE COST OF CANALS.

The cost of the whole of the Ganges Canal work is £2,300,000. Of this about one million was spent on bringing the water from within the hills, through a tract of country such as we have nothing to do with on the main lines of India. Of the remainder, a large portion was of course spent in distribution, &c , leaving much less than a million for the 700 miles of main canal, or from £1,000 to £1,500 per mile, for a canal varying from fifty yards to ten yards broad, or an average of about thirty yards.

The Kistna and Godavery Canal, 90 miles long, 25 yards broad, cost under £1,000 a mile. On all the main lines of India the cost now would probably average £2,000 or £3,000 a mile, for a canal thirty yards broad and eight or ten deep.

The estimate for the Lower Ganges Canal, I suppose one hundred yards broad at the head, is 2½ millions for two hundred miles of main line, including the irrigation works and a weir of two miles long across the Ganges.

If we allow half the expenditure for branch canals and irrigation, it will leave £6,000 a mile for a canal double the breadth of a steam canal.

As one of the unaccountable fancies that seize men that have not looked into this matter is, that there would be a difficulty in supplying canals with water, I will only mention here that if a canal cost £3,000 a mile, the portion of the expense that would be required for supplying the water would be about £100.

£2 COST PER ACRE OF IRRIGATION WORKS.

In the Godavery district it has cost 12*s.* an acre, including navigation, drainage, &c.; but, owing to the recent great change in the value of money, it would now cost about £2. The whole plain of the Ganges, containing half of our population, would be cheaper to irrigate than this, from the favour-

able nature of the country and the small size of the rivers to be controlled. If we allow an average of about £2, at the present value of money, we shall be safe, always of course supposing that the works are planned by men both of extensive experience and possessed of the necessary talents.

RETURNS PER ACRE FROM CANAL IRRIGATION.

If such works pay a water-rate of 3*s*. on an average, the direct returns would then be 10 per cent., and this is below what they are actually now paying wherever they have been tolerably planned. If the value of money continues to fall it will not affect the question, because the value of the water and the cost of the works will increase in the same proportion.

With respect to the total results, we cannot reckon the value of the crop from irrigation at less than £2 per acre. There is, therefore, not the smallest room for question about the capital being provided for, in the way of both indirect and direct profits; and it will be observed that these rates allow for navigable canals, so that the navigation will be obtained for nothing.

WATER-POWER ON CANALS.

On all our great irrigation works, wherever there is a lock there is a great water-power perfectly ready for use. I suppose there is at this moment 100,000 horse-power of water available in the different works; and it is in the best possible situation on the lines of transit and scattered over the most populous tracts. The water-power is not hid away in inaccessible and non-populous places, as is frequently the case, but exists where labour is at hand and where the produce of enormous tracts can be brought to the door of the mills, and the goods carried away to the markets and ports at a nominal cost of carriage.

CAPITAL REQUIRED FOR WORKS.

There are extraordinary natural facilities for water communication in India. The main lines shown on plan are all practicable and without one serious obstacle. The only point of the whole circuit that is impracticable is that between Carwar and Bombay.

Lines across the peninsula from Madras to Ponany on the west coast, from Madras through Bellary to Carwar, and from Co-

ringa to Surat by the valleys of the Godavery and Taptee; these three, with the two connections contained in the first circuit, give five lines connecting the east and the west coasts. So also a second line may be carried along the north side of the valley of the Ganges, to connect at both ends with the line first mentioned; and another main line may be carried from Calcutta to the eastward up the valley of the Burhampoota to the extreme east at Sadiya. These lines, with two or three main branches, and improving some of the rivers, would be about 12.000 miles, and could certainly be completed for £3,000 a mile, or for £36,000,000 in all, and they would connect all India together, and with all the ports. Many hundred miles of river can be improved at a small expense, on an average of about £1,000 a mile.

If half a million acres were irrigated in each district, or 65,000,000 acres in all India, it would cost about £130,000,000; and this would include most of the £36,000,000 above allowed for navigation, and also about £6,000,000 already expended on irrigation works; so that about £100,000.000 would be required to complete this system of works.

FIRST BUSINESS IS TO CONNECT ALL IMPORTANT LINKS.

The first question of course is, as matters now are, how can the next money be expended so as to give the greatest results? In consequence of the wretched patchwork way in which these works have hitherto been carried on, extensive systems of navigation are left unconnected for want of short lengths of canal. Thus the North and South Coast Canals at Madras are in a great measure paralyzed for want of a connecting link of three miles. The Northern Canal and the Kistna Canals are separated by a line of 100 miles. The Southern Coast Canal is broken by two intervals, one of 60 and one of 20 miles. The Indus and Ganges navigations are separated by a line of 150 miles from the Sutlej to the Ganges Canal; the lower Ganges and Calcutta by a line of 150 miles; the Burhampoota and Calcutta by a few short lines of about 100 miles in all. The Orissa canals, and those of the Godavery by about 250 miles. The canals and rivers on the west coast are in the same way divided by several short lines of a few miles each.

One of the first things to be done is to execute those short connecting links, so strangely left uncut hitherto, and in which

the money spent will produce such disproportionate results, by giving increased effect to so many thousand miles of navigation already in operation. After this the next thing to do will be to cut all additional lines that will lay open the populous tracts, mines, forests, &c., and connect them with the present system of navigation.

The completion of the present irrigation schemes.—Think of these enormously productive works being left year after year unfinished for want of £100,000 or £200,000, while millions have been spent in unremunerative works, which have entailed irritating taxes on the country. On the Godavery about £100,000 is required to irrigate 300,000 acres. Think of the Ganges Canal having been allowed to linger on for twenty years, and not half the land yet watered, for want of the works necessary to correct its defects and complete the distribution. But not only this, think of those invaluable works upon which not only the populations of those districts themselves, but of all the neighbouring ones, depend for their lives, not being even kept in repair. The late Upper Godavery Commission state that the locks in the delta were out of order, and that one main line of canal had been closed for nine months. And this is corroborated by a settler there, who states that many of the canals were useless from want of necessary repairs, and that land yielding £30,000 in revenue had been thrown up from the failure of the supply of water. Who could believe it possible that even in our day there could be such astonishing neglect of these vital works? The first thing therefore to be done on this point is to repair, correct, complete, and extend all the present projects. All money so expended, if laid out with ordinary engineering skill, will make immense returns, because all the heavy works connected with these projects having been already constructed, what remains to be done will be disproportionately productive.

Then also the main canal to connect Calcutta with Cuttack is ordered to be stopped short of an effective temporary terminus at tide-water, near Balasore, instead of being pushed on with all possible vigour to Calcutta. The price of rice in Orissa in December, 1873, was £4 a ton, and in Nuddeea, near Calcutta, it was £9—a difference of £5 for a distance of 250 miles, over which it could be carried by canal for a few shillings. Thus the price of rice where they wanted to buy was nearly double the price it might have been bought at, or

half what they might have got for it where they wanted to sell. Think of food being sold in a district at the famine price of 1*d.* a pound, in 1874, when it was selling within 250 miles at less than ½*d.*, for want of one link of canal of about 80 miles.

With a system of canals, the cost of carriage from one end of India to the other would be under £1 per ton, making a most serious difference in the cost.

NEXT EXPENDITURE ON STORING WATER FOR THE DRY SEASON.

The next expenditure should be in storing water to complete the supply throughout the year to the great irrigation works now in operation. The Godavery, the Kistna, and the Cavery, for instance, have only a small supply of water during the dry season, and thus the channels are little or not at all used during part of the year. About 3,500 million cubic yards are required to complete the supply of each of these deltas, or 10,000 in all, which would cost one million. But in doing this the same water will improve the navigation of the rivers by which it is conducted from the tanks to the irrigation. Thus from 500 to 1,000 miles of the Godavery, and its branches, would be greatly improved as navigations by this addition to their streams in the dry season. The present stream of the Godavery at the end of the dry season is 300,000 cubic yards per hour, and if water were stored fully to supply the irrigation, the stream would be kept to one and a half million cubic yards, or five times the present supply, which would make quite a good navigation.

A tank has just been finished near Sholapoor containing 120 millions cubic yards, besides what would pass through it in the monsoon, probably 40 millions more. It cost £80,000, or at 7 per cent. £5,600 per annum—£35 per million cubic yards. I need not give the calculations in this paper, but at this rate the actual cost (with not a favourable site for a tank) of water for a canal would be almost imperceptible. The lockage water, for instance, would be about ten cubic yards, for a ton of goods, and this would of course pass it the whole distance from the head level of the canal to the coast, perhaps 500 or 1,000 miles.

WORKS MUST BE BEGUN IN EVERY DISTRICT.

The further expenditure should be spread over all India. Such works ought to be begun at once in every district, that all may share in the benefit, and that a certain supply of food may be secured to every portion of the country. One crop of rice on 65 millions of acres would secure food for about 160 millions of people, or more than our whole population; but, of course, all the irrigated land would not be employed in growing food only. An expenditure of £60,000 or £70,000 a year should be immediately allowed for every district for the commencement of both storing and distributing water.

Many long papers have been written, showing how immensely valuable irrigation is, and indeed how absolutely necessary; at the same time pointing out no end of imaginary difficulties that lie in the way of it, and of imaginary ways of meeting them, but never doing one single thing completely. When a man can be found who will write nothing but a simple order for a loan to be raised and works commenced, we may hope for something. But nothing is so destructive of all hopes about it, as those official papers on the immense advantages and necessity of irrigation. A volume of such papers has lately been published, all filled with fine writings, but not one word about doing. If India could be irrigated with ink, the famines would have been stopped long ago; but I should prefer a Governor-General, or head of the Public Works Department, who would irrigate one acre or cut one mile of navigation, to one who would write a whole blue-book full of frothy declamation about the necessity of irrigation and the terrible difficulties attending it. The sluggard says, there is a lion in the way. That I am not beating the air in pressing this point I give a perfect specimen of the present course.

DON'T WANT INTENTIONS, BUT IRRIGATION WORKS.

In the Budget speech at Calcutta, it was said, "If any doubt has hitherto existed as to the expediency of engaging in great and extensive schemes of irrigation, that doubt has been completely dispelled. There can be no deliberation in dealing with famine. The issue forced upon the Government has been not whether it shall engage in speculation which may yield an uncertain profit, but whether whole districts of the country

shall be exposed to a periodical depopulation for want of those preventive measures which human power can command. Irrigation in India, is the great question of the day, as the repeal of the corn-laws and unrestricted commerce were the great questions in England in days gone by; but all that the repeal of the corn-laws and free trade have done for England, and much more than all, can be done for the people of India by works which will fertilise their fields, and place their means of subsistence beyond the reach of accidents," &c. This is continued through many more paragraphs. This is a specimen of what is said and written by the antagonists of irrigation; for those who say the things ought to be done, and do not do them, are the real antagonists. Thus nothing is to be done for the extension of irrigation. It is of no use saying, "But you don't know what we intend to do next year." The question is not about what it is intended to do, but about what is really done. Whether a thing is really done, or is only intended to be done, makes the whole difference We do not want intentions, but irrigation. Famine will never be prevented by intentions. Are we to judge men by their words or their deeds?

It must be particularly observed that this system has been continued under successive heads of the India Office, and under different financiers. . . . Nor is there the sign of commencing upon such a general and effective system of works; not a sign of that being done in irrigation and navigation which has been done about railways. What can be done to put an end to this fearful and ruinous system, this putting off from year to year these vital works, as will lead to an intelligent and effective prosecution of this essential enterprise, the irrigating and navigating India?

A BOARD AND ITS FUNCTIONS.

Nothing can be more evident to my mind than this, that while the work is left in the hands of the Councils, nothing can possibly be expected. What would be thought of the proposition that the ministry in England should themselves manage the Public Works? How could it ever be imagined that the Councils, who had upon them the whole multifarious affairs of government, could afford time and attention sufficient to enable them to control and manage the Public Works themselves?

I cannot but think that to any person who will consider this

subject ever so little, it will appear that, till there is a Board of three or four, whose sole business it is to attend to this one thing, and will thus be able to take sufficient interest in it, to acquire sufficient knowledge of the subject, and to have sufficient authority, it is altogether out of the question that the matter should be intelligently and vigorously prosecuted. A Board should be composed of a few members, so that they will not impede one another. What we want is action; and for this a very small number is essential.

Such a Board could lay before the Government the whole subject in a digested form, suggest the sums that should be expended annually, have a complete scheme of works for all India sketched out, take charge of the loans, order the expenditure, keep an account with the treasury of all money received as returns, give in a complete statement of all moneys to be laid before Parliament every year, and show the exact result of the whole expenditure, both directly and indirectly, as far as can possibly be ascertained. Such a Board, if at all justly selected, must of necessity soon take a high interest in the sole work they had to do, and they must soon acquire such a knowledge of the subject as to distinguish between plausible nonsense and solid reasoning in the engineer's reports that were laid before them. I of course do not attempt to go into details about the arrangement of such a Board; I only insist upon this, that nothing can be expected till there is such a Board who have nothing else to attend to, and who will feel their responsibility to the nation, to whom the loans will be intrusted without any power of the financier to meddle with them, or apply them to other purposes of the State, and who will be under the necessity of showing to the public clearly what the result of their management is.

WE SHOULD DO OUR DUTY.

Upon this regulation of water depends whether India is a reproach, a source of weakness, anxiety, and impoverishment to the empire, or a source of immense wealth, of unbounded supplies of materials for her manufactures, and of demand for her goods; of strength and honour to us as a nation and as Christians.

What are to be the consequences if we persist in thus doing till we have another famine? What do you suppose were the

thoughts of the assembled princes, when they were gravely and solemnly advised to take care of their people, while an immense portion of our own territory was at that very time strewed with hundreds of thousands of skeletons of men, women, and children, who had perished solely through our inconceivable indifference and merciless neglect? Can it be supposed that these polite princes were not saying to themselves, "Physician, heal thyself. Go back to Calcutta, and try to save the miserable remnant of those millions that you left to perish, and, when your people have saved them and restored to life the millions that perished, we shall be prepared to listen to your advice about our management of our people?"

We are at this moment mostly where we were as to any real setting to work in the matter. Certainly, three or four intended projects have been executed to a certain extent, but this is a totally different thing from setting ourselves about a general and effective scheme of such works, such as will really meet the exigencies of the case. I speak in a manner with authority, as a man who can speak from forty years' personal experience, supported by undeniable and indeed undenied results, both as respects complete preservation of vast tracts from famine, and also returns in money to the treasury as leaves no room for excuse on the score of want of funds.

WAYS OF ESTIMATING RESULTS.

In estimating the results of capital invested by Government, the first point always is, what is the total direct return in money to the community? and quite a secondary one, what are the direct or indirect returns into the treasury? It is of the utmost importance that this should be always kept in view. The case is quite different from that of a private speculation. In that case if a work does not return a fair interest to the investors, whatever the public benefit may have been, it is a loss to the company. But if, through any circumstances, say a work does not return nett 5 per cent. to Government, but at the same time benefits the people to the extent of 20 or 30 per cent., it is really an immense benefit to the country and even to the treasury, because it is impossible to enrich the people without all the different items of the revenue increasing. The produce of an acre of rice, 1,200 lbs., at the famine price of 1½*d*., would be £7 10*s*., nearly twice the whole cost of the most

expensive of these works, so that in a famine year the whole will be paid at least twice over by a single crop. This would give some idea of the insignificance of the costs of these works with their effects, leaving out the question of life and death to both man and cattle.

COST OF STORING WATER.

We have extensive data for estimating the cost of such works as we have for river works, but we generally calculate they will cost about £100 per million cubic yards of capacity, which, as it would be filling at intervals during the monsoon, would perhaps afford one and a half million cubic yards of water; but if such a work were intended to keep up the supply during the whole dry season, we must allow for the evaporation, which would leave the available supply of the tank about the same as its capacity. Now, allowing 6,000 cubic yards of water to irrigate an acre of rice, this would be at the rate of £100 per 170 acres, or 12*s.* an acre, as the cost of storing besides that of distribution, making it much the same as the cost of river irrigation.

But these tanks accomplish two other purposes. If they were placed high up in the country, and the water is applied in the dry season, they will improve the navigation of the rivers between the tank and the cultivation. Thus, if water were stored in the interior to provide for extended cultivation in the Godavery Delta during the dry season, it would improve the navigation of 1,000 miles of the Godavery River and its branches, which alone would pay for the tanks. A tank of 1,000 million cubic yards would supply a stream of 300,000 cubic yards per hour.

AT WHAT COST IRRIGATION CANALS CAN BE MADE NAVIGABLE.

GENERAL STRATCHEY ON THE IMPORTANCE OF NAVIGATION.

In any projects for irrigation canals the importance of making lines of navigation should be carried in mind. A line of this sort from the salt mines of Pind Dadam Khan to Lahore,

whence communication would be given to the eastward, would be of the greatest importance to the salt revenue and salt-consumer, as supplying the cheapest possible mode of transport.—(B. B., 389, 1870.)

I would strongly urge the early consideration of the advantages to be derived from rendering the chief part of this system of canals (remodelling Western Jumna) navigable. I think there can be no doubt that the line from Delhi to Kurnool, and the branch to Hassi, or Hissar, should be made navigable as early as possible. From this line of navigation a canal would join into the Sutlej Canal in the neighbourhood of Puttiallah, and thence a communication got with the Sutlej and the Punjab. Above Kurnool there will be no serious difficulty in making a canal navigable also.—(B. B., 389, p. 13.)

The question of navigation has not been seriously taken up in relation to the Baree Doab Canal. It is very necessary to do this. The first desideratum would seem to be to give water communication, viâ Lahore, between the Ravee and Sutlej. The canal leading from the latter river should be placed conveniently with respect to the navigable line leading from the new Sutlej Canal. The navigation should be connected with Umritsur certainly.

I also draw attention to the importance of making all new irrigation works undertaken in these districts (of the Bombay Presidency) subservient, as far as possible, to purposes of communication. Wherever it is possible, the canals should be constructed so as to be fit for navigation, and in designing all masonry works attention should be paid to this.—(Extracts from B. B., East India Irrigation.)

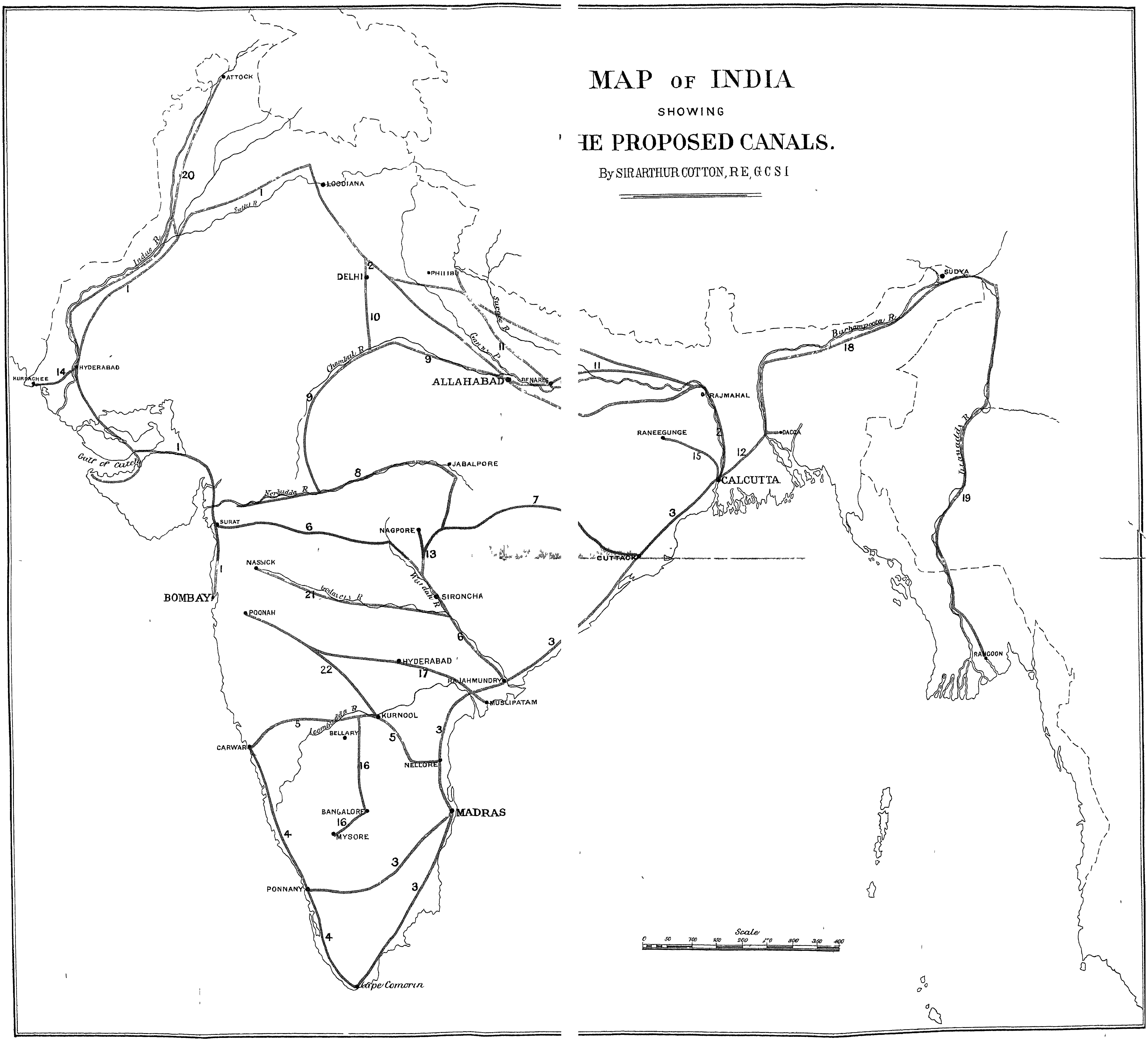
AT WHAT COST CANALS CAN BE MADE NAVIGABLE.

COLONEL RENDALL,

Secretary, Irrigation Branch, Government of India, states, in his report on Orissa canals, published in the two-volume Minutes of Evidence taken before the Parliamentary Select Committee, 1872, that the total cost of works per acre will be £1 16*s*., and 4*s*. per acre may be taken as the proportion due to navigation.

SIR A. COTTON.

The mere cost of fitting an irrigation canal for navigation is very small. The cost of large locks is about £200 a foot of fall, or £200 per mile of canal, if the fall is one foot per mile.


MAP OF INDIA
SHOWING
HE PROPOSED CANALS.
By SIR ARTHUR COTTON, R.E, G.C.S.I.
ATTOCK
LOODIANA
Indus R.
DELHI
HYDERABAD
KURRACHEE
ALLAHABAD
BENARES
Chambul R.
Gulf of Cutch
JABALPORE
Nerbudda R.
SURAT
NAGPORE
NASSICK
BOMBAY
SIRONCHA
POONAH
HYDERABAD
RAJAHMUNDRY
MUSLIPATAM
KURNOOL
BELLARY
CARWAR
NELLORE
MADRAS
BANGALORE
MYSORE
PONNANY
Cape Comorin
RAJMAHAL
RANEEGUNGE
DACCA
CALCUTTA
CUTTACK
SUDYA
Burhampoota R.
RANGOON
Scale

ESTIMATE WITH MAP OF NAVIGATION CANALS FOR ALL INDIA.

(By Sir Arthur Cotton, R.E., K.C.S.I.)

The map shows the lines of water communication I propose; some of these canals, and some rivers improved. All these lines I know to be practicable, and they bring many cities and many populous tracts within reach of each other.

The cost of a combined irrigation and navigation canal will depend upon the extent of irrigation. To irrigate half a million acres of rice at the same time requires a canal 100 × $2\frac{1}{2}$ yards; such a canal would now cost, in all its details, from £3 to £8 per acre, or allowing a second crop of other produce of the same extent, from £2 to £4 per acre. The length might be 500 miles, costing from £3,000 to £6,000 per mile, being three times the breadth required for navigation. A navigation canal 30 yards broad would cost from £1,000 to £3,000.

COST OF EXCAVATIONS AND LOCKS.

The excavation for a navigation canal would be about 30 × 1 yard in the centre between two locks, and about 35 × 3 yards at the locks; average 70 square yards × 1,760 = 12,500 square yards, at $2\frac{1}{2}d.$, would be £1,250; add 3 feet of lift per mile, at £250 per foot for locks, £200, making £1,450; add for land aqueducts £1,000, total £2,450 per mile of navigable canal, or say £3,000 at present prices. But no detailed estimate can possibly be so decisive and conclusive as the actual cost of canals already constructed in India.

ROUGH ESTIMATE OF EACH LINE OF NAVIGATION.

No. on Plan.		Length.	Average Cost per Mile.	Total Amount.
		Miles.	£	£
5	Nellore, on East Coast, north of Madras to Carnar	500	4,000	2,000,000
6	Rajahmundry, on East Coast, to Surat on the West . . .	800	3,000	2,500,000
7	Cuttack to Nagpore	600	3,000	1,750,000
8	Near the mouth of the Nerbudda by Jabulpore to Sironcha on the Godavery	800	3,000	2,500,000

No. on Plan.		Length.	Average Cost per Mile.	Total Amount.
		Miles.	£	£
9	Allahabad by the valley of the Chambul to the Nerbudda	700	4,000	2,750,000
10	Delhi to the Chambul	200	2,500	500,000
11	From the Surgoo near Philibut to Benares and to Rajmahal	800	3,000	2,500,000
12	Calcutta towards Dacca	120	2,000	250,000
13	Nagpore to the Wurda	180	3,000	500,000
14	Hyderabad in Sinde to Kurrachee	120	2,000	250,000
15	Raneegunge to Calcutta	100	2,500	250,000
16	The Toombudda near Bellary to Bangalore and Mysore	350	3,000	1,000,000
17	Hyderabad to Muslipatam	200	4,000	750,000
18	Dacca to Sudya on the Burhampoota and the Irrawaddy	800	2,000	1,500,000
19	From the highest point of Irrawaddy to Rangoon	800	1,000	750,000
20	Attack on the Indus to confluence of the Sutlej and Indus	400	1,000	500,000
21	Nassick, near the source of the Godavery, to Sironche, at the confluence of the Wurdah	500	2,000	1,000,000
22	Poona to Kurnool	400	2,000	1,000,000
1	Bombay to Loodiana, up the left bank of the Indus, with branch to Gulf of Cutch	1,600	3,000	5,000,000
2	Loodiana to Calcutta, with branch on the north bank of the Ganges	1,700	3,000	5,000,000
3	Calcutta to Cape Comorin, with branch from Madras to Ponnany West Coast	1,800	3,500	6,250,000
4	Cape Comorin to Carwar on the West Coast	600	2,500	1,500,000

Of this about 1,350 miles by canal and 3,150 miles by river is now in use, about 1,000 miles of canals is under construction, leaving 9,000 miles to construct, which, at £3,000 per mile, will require £27,000,000 or say £30,000,000 sterling, including four navigations quite across the country.

SAFE AND SPEEDY COMMUNICATION.

The convenience of safe and speedy communication belongs to railways as well as to steam-boat canals. The projected State railways are being constructed for a speed of fifteen to

twenty miles an hour. The same speed can be obtained on a steam-boat canal. All doubt on this point will be removed from this fact, that for the India Office, the London firm of Messrs. Thorneycroft have constructed canal passenger steam-boats, 87 feet × 12, and 2½ yards amidships, guaranteed to run twenty miles an hour; a small boat, built and engined by the same firm for the Lieutenant-Governor of Bengal, steamed on the Thames, in March, 1873, at twenty miles an hour.

On a canal everything will be carried at its own speed and its own time. There will be less dangers on a canal than on a railway; the great mass of the traffic may be carried on, as it certainly will be, at the most economical speed, which is a very low one, and the very few fast boats will run nothing like the risk that the passenger trains do on railways. The number of passengers and the class of goods that require a high speed in India is utterly insignificant; on 5,600 miles of railway open, the first-class passengers, including all season-ticket holders, do not even form 1 per cent. of the total passengers carried; the proportion of second-class is 6 per cent.; while no less than 93 per cent. are third-class passengers. The same remark is applicable to the class of goods, consisting chiefly of bulky agricultural produce. What will just suit India, and will provide all her wants, is combined irrigation and navigation canals, not railways.

CONCLUSION.

These canals all to be commenced in each district and finished in about five years. Nothing is more remarkable than this wonderful adaptation of our whole Indian empire for such a perfect system of water transit; and I may mention here that there is only 250 miles between this system and the vast system of internal navigation in China, so that a line of communication of some kind between the Burhampoota and Yangtsee would throw open all India to all China, and make Calcutta the port of a considerable part of the produce of China. It is evident that these lines would open the port of Bombay both to Scinde and the Punjaub, and also to the valley of the Taptee.

STEAM BARGES TO RUN IN THREE FEET OF WATER.

During the famine in Bengal in 1874, for the purpose of conveying grain and rice into the heart of the country, a fleet

consisting of ten steamers and five barges, each 90 feet in length, and capable of carrying, the former 27 tons and the latter 60 tons of grain, were constructed by Messrs. Rennie, of London, and Messrs. Hamilton, of Liverpool, by order of the India Council.

Each steamer is 90 ft. in length, 14 ft. in breadth, 5 ft. 6 in. in depth, and with a draught of 2 ft. 9 in., when fully equipped with coal, &c., and carrying a load of 21 tons of rice; carrying 27 tons of rice her draught will be increased to 3 ft. She is iron-built, and is divided into four independent compartments. The forward compartment contains accommodation for the crew and also affords hold-space. The second section is devoted entirely to hold-space; in the third are the engines and boiler, while the fourth is wholly for stowage. The steamer is propelled by twin screws, each screw being 3 ft. in diameter and 6 ft. pitch. Each screw is driven direct by its own independent horizontal engine, having a 12-inch cylinder with 10-inch stroke, the pair indicating 100-horse power. Steam is supplied from a short horizontal tubular boiler, and the working pressure is 60 lb. per square inch. Upon the trial trip of the first of these steamers, which was made down the river Thames, with her engines running at 250 revolutions per minute, she developed a speed of 9 miles per hour, indicating 100-horse power, and in all other respects gave perfectly satisfactory results. When its mission of mercy is ended, there are many purposes to which these vessels are applicable. They will then enter upon a wide field of usefulness, and will solve important questions of internal transport now under consideration. In fact, the opinion was expressed that the present vessels would possibly form the pioneers in India of a very large number of their class.

The barges, towed by steamers, correspond in dimensions and build to the steamers, each carrying 50 tons of grain at 2 ft. 9 in. draught, and 60 tons at 3 ft. draught.—*Times*, April, 1874.

SOCIAL AND POLITICAL EFFECTS OF CANALS.

EFFECT OF CANALS ON A PLUNDERING TRIBE.

(By Col. B. Smith, R.E., C.B.)

I have repeatedly, in my own limited experience, turned tracts of country notorious for the lawlessness of their people into broad sheets of cultivation, by the simple expedient of running irrigation channels through the hearts of them. I may tell here a short story of the mutiny. My friend and assistant, Mr. Willcocks, was obliged to fly from his station on the Eastern Jumna Canal in May, 1857, accompanied by his wife, three children, and an assistant overseer, Sergeant Brown. The party had many narrow escapes in working their way from the vicinity of Delhi towards Saharunpore, but managed to reach the western part of the latter district, when they were all taken possession of by a party of Goojurs, and carried by them to their village. There they were hospitably cared for for about a month, housed in the best house the place afforded, and protected against all injuries, their Goojur protectors having on one special occasion shown perfect readiness to fight a body of mutineers or rebels who required the Europeans to be given up to them. Willcocks and Brown, however, being both resolute men, and the aspect of their party being threatening, the mutineers moved on. Thus matters continued till the country was more settled, when the head man of the village, with a strong party of his people, escorted his guests into the station of Saharunpore, and delivered them over to the magistrate in all honour and in good condition. The village was a canal village, and on hearing of its conduct I took upon myself to grant at once the use of as much canal water as it could employ free of all charge for ten years, and the last private note I ever received from the late Lieutenant-Governor, Mr. Colvin,

expressed his full approval of the grant. Goojurs though the people were, the temptation to industry was really irresistible, and in about two years they had brought very nearly all the land of the village capable of being irrigated under irrigation, increasing their profits, of course, very largely.—(Extracts from special Report on the Famine of 1860-61, North-West Provinces, pp. 76, 77.)

POLITICAL OBJECT OF CANALS.

(Evidence of Sir R. Montgomery, K.C.B.)

The upper part of the Baree Doab Canal was highly irrigated from wells before the canal went there; but the object of taking the canal was to go down past Amritsur and Lahore into a very barren district of country called the Maujha, which is the country of the Sikhs. There is a certain degree of cultivation there, but an enormous quantity of waste land. That was one of the great political objects with which the canal was started, to turn the Sikhs from war and warlike feelings to agricultural pursuits; to take the canal right through their country, so that the whole of it might become cultivated, and that they might return to agriculture, and leave off their warlike pursuits. And now that canal has gone into a portion of the Maujha, not as far as we had hoped it would have done by this time; but the work is still going on, and in the course of two or three years I think it will reach a place near the bottom of the Maujha, and be continued to Moultan, so that an enormous breadth of country, in the course of a few years more, will be irrigated.

The irrigation is paid for by a water-rate; as the irrigation goes down, the Government assessment, of course, remains fixed on the village, but they pay a certain acreage for the water, if they choose to take it; if they do not choose to take it they need not pay for it, but they are so anxious to get it that they would almost do anything to obtain it. In the other doabs, more particularly in the Rechna Doab, a similar canal would be productive of very beneficial effects.—(Evidence before the Select Committee, March, 1871, vol. i., p. 51.)

EFFECTS ON A WILD PEOPLE.

The district of Mairwara was brought into subjection by Colonel Hall in 1820, and his successor, Colonel Dixon, in

1835, constructed tanks and reservoirs on a large scale. Between 1836 and 1846, as many as two thousand tanks were constructed, irrigating 14,826 acres of land. The once-wild and unruly Mairs become a thrifty, peaceful, and industrious peasantry, under the influence of these improvements and of such men as Hall and Dixon.—(B. B., Progress Report of India, 1873, p. 53.)

SAVING OF £13 PER EACH PERSIAN WHEEL.

The Bigari Inundation Canal, on the right bank of the Indus, is the most interesting in Sind. In 1844 it was described by Lieut. Maclagan as having a total length of forty-eight miles, with a fall of 35 feet. The head was on a side channel, at a distance of nearly seven miles from the Indus. In 1851, General Jacob, Political Superintendent of the Upper Sind frontier, represented to the Commissioner (Sir Bartle Frere) the great advantage of enlarging the Bigari. It was then becoming yearly smaller, from the defective system of clearing. At the head it was 24 feet wide, with a depth of 9 feet. It was proposed to enlarge to 40 feet, with a depth of 11 feet, and to slope the banks to a proper gradient. The Núrwah was the chief offshoot of the Bigari, and had been carried far into the desert north of Khangarh. General Jacob, in 1852, proposed that the Núrwah should also be cleared and enlarged. He entrusted the work to a native contractor, who had to remove enormous heaps of earth, 25 to 30 feet high on the banks, to cut away jungle, and to clear dams out of the bed. The contractor did his work well, though only a common Sindhi maistri, and completed it in 1854. The capacity of the Bigari was about doubled by the new excavations, and much wheel irrigation was converted into natural flow with a saving, each season, of 130 rupees for every wheel. Villages sprang up along the Núrwah, where a few years before people scarcely ventured to take their flocks, from fear of Balúch plunderers.

HOW JACCOBUND WAS FOUNDED.

Jaccobund was founded in the midst of a barren, treeless waste. The water of the Bigari Canal was brought to Jacobabad, and the tail was extended thence to the Kelat boundary near Keragari (Khyra Ghuri). Now the former desert is a dense forest of babúl and other trees, upwards of 60 feet high,

sheltering the houses and gardens of the inhabitants. Within a few miles there is the desert again, which skirts the Baluchistan hills, a level plain of splendid, fertile, alluvial soil, but hard, naked, and barren, like a threshing-floor, without shrub, herb, or grass, except in the vicinity of canals.

There the desert is converted into a garden; woods took the place of sand, and the Bagari Canal revenue, which amounted to £4,796 in 1852, was £13,594 in 1857, and £17,339 in 1862. The improvements of General Jacob only cost £16,200.—(Extracts from B. B., 1873, pp. 45, 46.)

THE FORD-WAH IN BHAWALPORE.

The native state of Bhawalpore extends for three hundred miles along left banks of the Sutlej, Chenab, and Indus. The Trevewanna once fertilised a vast tract; but, owing to neglect, the feeding-channels and the Trevewanna itself silted year by year, and more land fell out of cultivation.

The people took to rapine for a living, and at last the whole north-east district of Bhawalpore became a mere population of cattle-feeders.

This was the state when Major Minchen, the political agent, assumed charge of Bhawalpore in 1867, during the minority of the Nabob. He borrowed £15,000 at 12 per cent. interest for ten years, and dug a canal called the Ford-wah, with the best results. A revenue of 12 lacks, paid in grain, increased to £190,000, paid in cash. The system of yearly clearances has been placed on a sound basis. This is a measure of the blessings conferred upon the country by the political agent and his coadjutors.—(Extract from "Progress and Condition of India," 1873, p. 41.)

COLONEL STRATCHEY ON POLITICAL VALUE OF IRRIGATION.

The value of permanent means of irrigation in the district west of the Indus would be very great, in a political as well as fiscal sense. Everything which would add to the wealth of the population and security of obtaining a means of existence, must conduce to the confirmation of habits of order and peace. In this point of view, it seems probable that attention should also be given to the irrigation of the Peshawur valley and the Yusufzaie country. There is no so powerful agent in the cause of civilisation as money. The possession of money derived from

honest labour, and the knowledge that the means of procuring it in this way were fully secured, would assuredly produce a very beneficial effect on the border tribes —(Blue Book, 389, 1870, p 15

CANALS FROM A MILITARY POINT OF VIEW

(Sir A T Cotton's Cross-examination before the Select Committee in 1872)

With respect to the comparison of a railway and canal, a canal, though it may be destroyed, is far more capable of defence than a railway, because you can keep armed steamers running upon it at all times, day and night, independent of the traffic, which you cannot on the railway, and another great thing in India is that an irrigation canal in use would have the whole population on the side of it, and it would be a very dangerous experiment for people to try and destroy a canal, the people would be inclined to protect it, whereas they would not care about a railway being destroyed.

Would it not be as easy to cut the canal banks as to tear up the rails of a railway?—Yes, but you can run your steamers, independently of the traffic on the canal, while on the railway you are obliged to keep the line open for traffic The canal is far more defensible, that is the difference

The railway projected from Lahore to Peshawur, I believe, is distinguished for the great number of streams which it passes? —Yes

And consequently the great number of bridges that would be necessary? —Yes —(Minutes of Evidence, vol ii p 452)

MORAL AND POLITICAL EFFECTS OF CANALS

(By B T Login, C E, late of the Ganges Canal)

In India the promotion of irrigation works becomes a matter of public policy as well as humanity, for the wide-spreading distress occasioned by want of water is liable to produce discontent On the other hand, the moral effects cannot but be beneficial, when, from one canal alone, and that in an incomplete state, more than a million human beings were fed by its produce in 1860, and the writer well remembers on that occasion the

* The cost of three iron bridges alone is estimated more than a

cry for water, and the satisfaction which its arrival caused among all the cultivators Only those who had the distribution of this water can fully appreciate the good effect such works must have on a population like that of India If every stream which now flows to waste from Oude to Peshawur were turned into irrigation canals, we should have a far greater military command of the country, for although no one would ever dream of closing a canal to quell a rebellion, yet the moral effect of our having the power to do so would at once make the industrious cultivators side with us in keeping the indolent and rebellious in order

The effect, therefore, of having half-a-dozen more canals like those from the Ganges, the Jumna, and the Ravee would possibly enable us to dispense with at least half-a-dozen European regiments, or, at all events, in the event of a war on the frontier, few troops need be left behind to overawe that portion of Hindoostan which produces the most warlike races of India Therefore, for political causes alone, there is every reason why a regular system of irrigation canals should be carried out in Oude, the North-west, and the Punjab—leaving out of view the far higher cause of humanity

The full development of irrigation would greatly enlarge the commerce between England and India, for irrigated land could support three times the present number of inhabitants of one of the most thickly populated portions of the globe

It has been shown that, owing to the Ganges Canal, as many lives were probably saved in Bengal during 1865-66 as perished in Orissa in 1868, and this canal in 1866-67 repaid to the country more than its total cost, while it was the means of feeding little short of two and a half millions of people

FINANCIAL ACCOUNTS AND DISCUSSIONS, IRRIGATION WORKS, INDIA.

CAPITAL OUTLAY ON WORKS IN OPERATION IN INDIA, UP TO 1872,

Showing the Expenditure, Extraordinary and Ordinary.

	Expenditure Extraordinary.				Ordinary.	Grand Total.
	Works.	Esta-blish-ment.	Tools and Plant.	Total.		
MADRAS.	£	£	£	£	£	£
1. Godavery Delta .	61,144	17,819	2,173	81,136	206,470	287,606
2. Kistna Delta Works	73,099	21,076	691	94,866	197,935	292,801
3. Pennair Delta Works .	34,179	8,805	229	45,213	57,334	100,547
4. Cauvery Delta Works .	26,262	5,251	148	31,661	27,519	59,180
5. Tank Restoration .	17,854	3,274	98	21,226	55,069	76,295
Total . .	212,538	56,225	3,339	272,102	544,327	816,429
N.W. PROVINCES.						
6. Ganges Canal .	164,322	55,462	4,315	227,655	2,463,114	2,690,769
7. Eastern Jumna .	5,326	1,085	367	6,778	210,119	216,897
8. Doan . . .	—	—	—	—	54,998	54,998
9. Rohilcund . .	2,263	502	128	2,893	64,398	67,291
Total . .	171,911	57,049	4,810	237,326	2,792,629	3,029,955
PUNJAB.						
10. Baree Doab Canal .	106,124	44,619	15,516	166,060	1,148,807	1,314,867
11. Western Jumna .	28,790	37,154	5,482	71,426	291,871	363,297
12. Upper Sutlej Inundation .	3,173	385	—	3,558	45,287	48,845
13. Lower Sutlej Inundation .	—	—	—	—	28,816	28,816
14. Indus I. Canals .	—	3,833	289	4,122	45,811	49,933
Total . .	138,087	85,991	21,287	245,166	1,560,592	1,805,758
SIND.						
15. Foolanee . .	—	—	—	—	27,519	27,519
16. Eastern Nara Canal	8,530	2,761	237	11,528	138,822	150,350
17. Sukhur Canal .	29,787	6,332	270	36,389	62,085	98,474
18. Biggaree Canal .	22,668	5,113	211	27,992	2,639	30,631
Total . .	60,985	14,206	718	75,909	231,065	306,974
Grand Total £	583,5[illegible]1	213,471	30,204	830,503	5,128,613	5,959,116

The above figures are taken from Finance and Revenue Accounts, 1872, presented to Parliament. The expenditure, called Extraordinary, shows the cost of works, establishment, tools, and plant separately, and is taken from p. 9. To the expenditure called Ordinary, taken from p. 110, we have *added* 25 per cent. for establishments, &c.

COST PER MILE AND PER ACRE IRRIGATED,

Showing the Length, in Miles of Main and Distributories; the Acres irrigated; Cost per Acre irrigated; and Cost per Mile of Main Canal and Distributories.

	Length.		Acres Irrigated.	Capital Outlay.	Cost per Acre.	Cost per Mile.	
	Main.	Distri-butories.				Main.	Distri-butories.
MADRAS.				£	£ s.	£	£
1. Godavery Canal .	700	—	222,032	287,606	1 6	411	—
2. Kistna Canal .	400	—	144,591	292,801	2 0½	732	—
3. Pennair Delta Works .	—	—	875,069	100,547	0 4	—	—
4. Cauvery Delta Works .	—	—		59,180		—	—
5. Tank Restoration	—	—	no return	76,295		—	—
Total . .	1,100	—	1,244,692	816,429	13 1	739	—
N.W. PROVINCES.							
6. Ganges Canal .	654	3,069	766,614	2,690,769	3 10	4,114	877
7. Eastern Jumna .	130	606	212,714	216,897	1 0¼	1,667	358
8. Doon . . .	—	67	12,419	54,998	4 8	—	821
9. Rohilcund . .	150	—	56,233	67,291	1 4	448	
Total . .	934	3,742	1,047,930	3,029,955	2 18	3,244	809
PUNJAB.							
10. Baree Doab Canal	212	692	279,210	1,314,867	4 10	6,202	1,900
11. Western Jumna .	405	259	462,707	363,297	0 16	897	1,403
12. Upper Sutlej Inundation	—	—	77,070	48,845	0 13	—	—
13. Lower Sutlej Inundation	—	—	202,036	28,816	0 2½	—	—
14. Indus I. Canals .	—	—	174,342	49,933	0 6	—	—
Total . .	617	951	1,195,365	1,805,758	1 10	2,927	1,900
SIND.							
15. Foolanee Canal .	no returns			27,519		—	—
16. Eastern Nara Canal .				150,350		—	—
17. Sukhur Canal .				98,474		—	—
18. Biggaree Canal .				30,631		—	—
Total . .	. .	. .	. .	306,974			
Grand Total .	2,651	4,723	3,488,037	5,959,116	1 14	2,248	1,262

DIRECT RETURNS FROM IRRIGATION WORKS IN OPERATION, 1872.

Works.	Cost.	Acres Irrigated.	Water Receipts.	Repairs, &c.	Nett Profit per cent.
	£		£	£	
1. Godavery . .	287,606	225,032	67,509	11,251	19
2. Kistna . . .	292,801	144,591	43,377	7,229	12
3. Pennair . . .	100,547	875,069	262,521	43,753	90
4. Cauvery . . .	59,180				
5. Tank Restoration .	76,295	no return	no return	no return	
Total . .	816,429	1,244,692	373,407	62,233	38
6. Ganges Canal . .	2,690,769	766,614	191,037	87,725	$3\frac{5}{6}$
7. Eastern Jumna .	216,897	212,714	56,637	18,175	18
8. Doon . . .	54,998	12,419	4,311	2,469	$3\frac{1}{2}$
9. Rohilcund . .	67,291	56,233	2,941	7,420	
Total . .	3,029,955	1,047,980	245,926	115,789	$4\frac{2}{3}$
10. Baree Doab . .	1,314,867	279,210	73,356	37,797	$2\frac{1}{4}$
11. Western Jumna .	363,297	462,707	118,637	34,950	23
12. Upper Sutlej Inundation . . .	48,845	77,070	5,740	10,447	—
13. Lower Sutlej Inundation . . .	28,817	202,036	15,426	18,766	—
14. Indus Irrigation .	49,933	174,340	8,526	8,761	—
Total . .	1,805,758	1,195,365	221,745	110,721	6
15-18. Sind Works .	528,145	no return	no return	no return	no return
Grand Total .	5,959,116	3,488,037	850,078	110,721	19

No proper account of Irrigation Works in India has ever been published by Government. The official returns for N.-W. Provinces and Punjab include in repairs amounts spent as capital outlay. For Madras works no account, however incomplete, is ever published. Sir Arthur Cotton states the acres watered by the Godavery and Kistna works 500,000 and 300,000 respectively, while the B. B. Progress of India, 1872, states just 50 per cent. less. That statement we have assumed to be correct, though much below the real mark. The water-rate in Madras, the water being all flow, is 8*s*. per acre, but in calculation we have only taken at 6*s*. per acre. The Finance Accounts, 1872, give £9,800 repairs for all Madras works, to which if we add 30 per cent. for establishment, amounts to £12,500; but, in the above table, we have calculated at 3 per cent. on capital outlay, raising the repairs expenditure from £12,500 to £62,233, yet the Madras works show enormous profit.

CAPITAL OUTLAY ON IRRIGATION WORKS UNDER CONSTRUCTION OR PARTIALLY OPEN UP TO END OF 1872.

	Works.	Establishment.	Tools, Plant.	Total.	Ordinary.	Grand Total.
BENGAL.	£	£	£	£	£	£
1. Sone Project .	262,470	75,158	101,579	438,916	1,724	440,640
2. Orissa Project .	1,147,007	342,539	117,241	1,656,787	52,589	1,709,376
	1,409,477	417,697	218,820	2,095,703	54,313	2,150,016
N.-W. PROVINCES.						
3. Eastern Ganges .	6,769	13,745	863	21,377	89	21,466
4. Lower Ganges .	1,341	10,355	377	12,086	—	12,086
5. Agra Canal . .	57,640	20,169	4,844	302,306	1,385	303,691
	65,750	44,266	6,084	335,769	1,474	337,243
PUNJAB.						
6. Sirhind Canal .	273,881	94,369	26,860	395,153	545	395,698
BOMBAY.						
7. Moota Project .	232,247	24,895	3,026	260,168	440	260,168
8. Tholopore Tank .	89,337	17,371	1,391	108,099	540	108,639
9. Kistna, Sattara .	10,449	2,486	167	13,102	—	13,102
10. Lalk Canal, &c., Amednugga	16,621	3,507	276	20,404	8,661	29,068
	348,654	48,059	10,860	401,683	9,641	410,977
Grand Total	2,097,762	604,391	262,624	3,228,308	65,973	3,293,934
Add for all works nearly completed and in operation up to 1872 .						5,959,116
Grand Total State outlay on all irrigation works up to 1872 . £						9,253,050

Say, TEN MILLIONS STERLING.

ONE YEAR'S EXAMPLE OF IRRIGATION WORKS EXPENDITURE, ON OLD AND NEW WORKS, FROM ORDINARY AND EXTRAORDINARY FUNDS. (1872.)

	Repairs.	Re-modelling.	New Works.	Name.
N.-W. PROVINCES.	£	£	£	
Ganges Canal . .	3,333	23,805	86	Eastern Ganges.
Eastern Jumna .	1,233	1,198	203	Bundlekund.
Doon . . .	677	—	131	Lower Ganges.
Minor Works .	2,417	—	57,640	Agra Canal.
Total . .	18,484	25,003	58,060	N.-W. PROVINCES.
PUNJAB.				
Baree Doab . .	533	35,511	182,936	Sirhind Canal.
Western Jumna .	—	4,989	35	Surat Project.
Upper Sutlej . .	2,885	—	—	
Lower Inundation .	512	—	—	
Indus Inundation .	3,101	—	—	
Minor Works . .	867	—	—	
Total . .	8,816	40,500	182,971	PUNJAB.
MADRAS.				
Godavery Delta .	45	15,923	3,426	South Arcot.
Kistna Delta . .	2,192	8,331	9,895	Tinnavely.
Pennair . . .	—	8,000	426	Madura.
Cauvery . . .	—	10,385	—	
Tanks . . .	4,840	—	—	
Minor Works .	2,741	—	—	
Total . .	9,818	42,638	13,747	MADRAS.
BENGAL.				
Sone Works . .	—	—	150,000	Soane.
Orissa . . .	—	—	105,593	Orissa.
Total . .	—	—	255,593	BENGAL.
BOMBAY AND SIND.				
All Works . .	31,859	—	87,572	New Works.
Rajpootana . .	849	—	—	Rajpootana.
Burmah . . .	—	—	19,576	Embankments.
Total . .	32,708	—	107,148	
Establishment, 30 per cent. .	20,947	—	182,255	Establishment, 30 per cent.
Grand Total £	90,773	108,141	789,774	
	£988,688.			

The figures are from Financial Accounts of India, for 1872, B. B., pp. 108–112.

PROPOSED EXPENDITURE ON IRRIGATION WORKS, UP TO 1878,

For completing works in operation, or correcting defects in design, including new works under construction and projected.

		1873.	1874.	1875.	1876.	1877.	1878.	Total.
		£	£	£	£	£	£	£
MADRAS	Godavery, D. W.	18,000	49,000	40,000	40,000	18,000	—	165,000
	Kistna	11,000	16,000	30,000	30,000	30,000	30,000	147,000
	Pennair	8,500	6,000	—	—	—	—	14,500
	Cauvery	13,000	1,000	10,000	12,000	12,000	10,000	58,000
	Other Projects	27,500	19,000	30,000	30,000	30,000	30,300	166,000
BOMBAY	Moota Canal	37,000	61,000	19,000	—	—	—	117,000
	Taptee Project	11,000	8,000	8,000	50,000	50,000	50,000	216,000
SIND	S. E. Nara, Jhambres, and Metrow	10,000	5,000	20,000	20,000	20,000	20,000	95,000
	Desert Canal	—	—	20,000	20,000	20,000	10,000	70,000
	Small Projects	25,000	28,000	16,000	14,000	—	—	83,000
BENGAL	Orissa Project	203,000	167,000	160,000	160,000	160,000	160,000	1,010,000
	Soane Project	244,000	243,000	250,000	250,000	250,000	250,000	1,487,000
N.-W. PROVINCES—	*Re* Ganges Canal	218,000	37,000	47,000	45,000	45,000	45,000	264,000
	Agra Canal	105,000	101,000	56,000	—	—	—	262,000
	Lower Ganges	48,000	135,000	160,000	160,000	160,000	160,000	823,000
PUNJAB	Baree Doab	63,000	75,000	80,000	80,000	80,000	80,000	458,000
	Sirhind	174,000	290,000	256,000	250,000	250,000	250,000	625,000
	Western Jumna	44,000	56,000	100,000	100,000	100,000	100,000	500,000
	Minor Works	23,000	16,000	25,000	25,000	25,000	30,000	98,000
Total		1,060,000	1,326,000	1,373,000	1,292,000	1,256,000	1,225,000	6,907,000
Contemplated on Pennair Extension, Eastern Ganges, Surat, and other Projects		19,000	30,000	202,000	257,000	245,000	204,000	957,000
Total		1,079,000	1,356,000	1,575,000	1,549,000	1,429,000	1,429,000	7,489,000
Less, to be contributed by native States		110,000	90,000	100,000	100,000	100,000	125,000	625,000
Nett grant . . . £		969,000	1,263,000	1,475,000	1,449,000	1,401,000	1,304,000	7,864,000
Add outlay on irrigation works in operation, up to 1872								5,959,000
Add outlay expended on works under construction, up to 1872								3,293,934
Total State capital outlay on all irrigation works in India up to 1878								17,116,934

COST PER MILE AND PER ACRE IRRIGATED OF NEW CANALS UNDER CONSTRUCTION.

	Cost per Mile.	Per Acre.	Estimate.	Length of Steam-boat Canals.	Acres irrigated.
BENGAL.	£	£ s. d.	£	*Miles.*	
Sone Canal . .	2,710	1 18 0	3,775,000	1,393	2,000,000
Orissa . . .	5,229	1 14 0	2,771,396	530	1,500,000
N.-W. PROVINCES.					
Eastern Ganges .	3,462	2 0 0	900,000	260	455,000
Lower Ganges . .	3,042	—	1,825,000	600	
Agra Canal . .	5,228	1 18 0	575,000	100	300,000
PUNJAB.					
Sirhind . . .	6,475	2 11 0	1,980,000	305	783,000
BOMBAY.					
Moota Canal . .	—	—	—	100	70,000
Sholopore Tank .	—	—	—	10	22,000
Sattara Canal . .	—	—	—	—	44,000
Lalk Canal. . .	—	—	—	21	17,000

The length of canals stated above for Bengal, North-west Provinces, and Punjaub is adapted for steamboat navigation. For example, on the Sone Canal, the lock-chambers will be 120 by 20 ft., with 8 ft. of water, and have been designed to pass small steamers through them.—(*Engineering.*)

DISCUSSION IN PARLIAMENTARY SELECT COMMITTEE, 1872.

(Mr. Fawcett's Question to the First Inspector-general of Irrigation Works.)

I think I can prove to you that the returns will be very much less than they are represented. According to the official report on the irrigation works in the North-Western Provinces for 1869-70, the entire capital expended on them up to the commencement of said year amounted to £2,700,705. The nett earnings in 1869-70 amounted to £136,703, being equal to 5·06 per cent. of the above-mentioned capital. Said capital, however, does not include the sums that have been paid year by year to meet the excess of charges (including interest) over revenue. These charges amounted to £917,800, so that the total outlay was actually £3,618,505, and the nett profits of the year, calculated on this sum, amounted to only 3·8 per cent. This is the accumulated interest of surplus charges over revenue which have accrued up to date.

REPLY TO THE QUESTION.

I take the Ganges Canal, for instance. The construction of the Ganges Canal began in 1842, and the Government having no money to speak of to spend upon it, it went on very, very slowly, and was not open till 1854; but that was simply because the system of borrowing money for works of this sort had not been adopted, and of course there had been a very considerable accumulation of charge on account of the works during those twelve years.

Here are the accounts of the Ganges Canal from the year 1855-56 up to the present time. The increase of the total revenue from 1863-64 up to the present time is as follows:—In 1863-64 it is £84,000, in 1870-71 it is £216,000, and making allowance for the charges, the nett income has increased from £28,000 to £128,000. That is the Ganges Canal. That great increase is no doubt due to a considerable extent to the actual extension of the irrigation. But here is a case of one of the old canals, in which the total quantity of water is pretty much the same now as it was then.

On the Eastern Jumna Canal in 1863-4 the revenue was £33,000, and in 1870-1 it is £72,000, the nett being £22,000 in the first year and £53,000 in the last. And similar results will be found from the other principal canals. The Western Jumna Canal gives an equally striking illustration of it; in 1863-4 the nett revenue was £63,000, and in 1870-1 it is £121,000. Now I say that if these results have been possible during these last seven or eight years, the Government, as regards that class of canals, in my judgment, is thoroughly justified in believing that the results of similarly constructed new canals will be no less favourable. The causes for the slowness of the development of the irrigation, and of the revenue of the Ganges Canal, are well known, and have been explained before.

There have been extravagant claims made on behalf of Madras works, but the conclusion I came to myself, after having been there, and having examined the whole of the data, is that the returns from the Madras irrigation works are very large: according to my estimate, which I believe to be tolerably fair, the return on the Godaveri irrigation works is about 22 per cent.; for Tanjore the returns may be 20 to 25 per cent. (6,664).

To that there is a large increase to the revenue, which, under

the system of collecting the land revenue, is taken as increase of land revenue. The mere fact of famine in its worst form being impossible in a district which was before liable to it, is in itself a very great advantage. And another of the very great contingent advantages of these irrigation works which have to be seriously considered in adjusting the payments that are to be made for them, is the fact that they prevent one of the first results of a drought, which is the destruction of the agricultural cattle. By having a permanent stream of water flowing through the country, and by providing a permanent and unfailing source of fodder for the cattle of the country from one end of it to the other, you practically are able, under the most unfavourable circumstances, to support cattle.

If the question is asked, if in any case a profit is not derived in money from such works, how the Government can justify the construction of those works, I say, without hesitation, that a sufficient reply is given if it is said that they will preserve, as I believe that they will preserve, the lives of millions of the Queen's subjects, and that they will protect from destruction in the very worst form districts many times larger than the United Kingdom.—(Extracts from evidence of General Stratchey, June, 1872.)

EVIDENCE OF COL. G. CHESNEY, R.E., ACCOUNTANT-GENERAL P.W.D.

On the Ganges Canal, which is the largest irrigation work, the supply of water is, generally speaking, not equal to the demand of the cultivators. In times of drought the canal is not able to supply sufficient water for cultivators. There have been two cases of very severe drought which would have resulted in a famine, but for the canal. It is hardly to be doubted that if the canal did not exist, the remissions of the land revenue for 1860-61, and in the great drought which followed a few years afterwards, would alone have amounted to the capital expended.

The loss of previous years had been carried to capital account. —(June 3, 1871.)

EXTRACT FROM COL. G. CHESNEY'S WORK.

The Ganges Canal was commenced under the influence excited by the great famine of 1838, but the progress was suspended, and was not resumed until 1847.

The famine of 1861 drew attention back to the subject, and showed how much still remained to be done to perfect the means of irrigation available

RESOLUTION, GOV N W PROVINCES, ALLAHABAD, APRIL, 1872

Ganges Canal —The navigation returns are still far from being at all adequate to the opportunities of traffic afforded by the canal This is due mainly to the bar presented by the low bridges This defect has been remedied by the rebuilding of the bridges, and only a few remain with the original low curve

FINANCIAL RESULT OF MADRAS WORKS—FINANCE MINISTER'S STATEMENT, 1873

As regards the Madras irrigation works, I can affirm—having had the advantage of studying the subject on the spot in company with the best informed authorities—that they are eminently successful, and abundantly remunerative in the highest sense both to the State and to the people, and that the benefits, direct and indirect, are so great that they can hardly be represented adequately by any regular account, in whatever form it may be prepared —(Sir R Temple's Minute, March, 1873)

DEFECTS IN DESIGN AND SLOW PROGRESS—BAREE DOAB CANAL RESOLUTION, GOVERNMENT OF INDIA, AUGUST, 1864

The main cause that has operated to raise the charge for repairs, and retard the spread of irrigation, is the same defect as has operated in the case of the Ganges Canal The slope of the bed with which the canal was designed and executed, has proved too great, and the velocity of the current has, therefore, been excessive, and has injured the bed and banks The falls, being on the vertical system, have worked well But extensive works must be carried out to remodel the bed of the canal before it can be worked efficiently Improvements are also required in the head works to give more efficient protection in times of flood

EVIDENCE OF SIR R. MONTGOMERY BEFORE THE P. SELECT COMMITTEE, 1871.

Baree Doab Canal.—The nett return sufficient to pay the interest on the capital—not yet; but the canal has not come into full operation, nor have the irrigating branches. If you have a canal, you require hundreds of irrigating branches; I do not think they have been all made yet.

When this canal is completed, both for navigation and irrigation, the revenue from the canal will be sufficient to pay the interest on the outlay, I think; but you must bear in mind that for about twenty years whilst it was constructing, there was next to nothing received.

The fact of the matter is this, that the canal ought to have been made much faster, but the Government merely gave money as they were able to give it. As they were hard pressed they dribbled. If the Government would borrow money, they could carry the canal through in a few years. And it would be much more profitable then, because they would get a quicker return.—(Extracts.)

IRRIGATION STATESMANSHIP.

GOVERNMENT OF INDIA RESOLUTIONS, &c., FROM 1861 TO 1874.

We fully assent to the doctrine that our surplus revenue should be the fund from which to supply the requirements of the country for public works; but if this should prove insufficient, we should be disposed to consider favourably any practical scheme that had for its object the provision of whatever funds were considered needful for the prosecution of irrigation works with proper vigour, by means of loans raised to supplement the ordinary revenue.—(Extract B. B., p. 3, signed by John (Lord) Lawrence, &c.)

GRANTS FOR NEW WORKS AND REPAIRS FROM 1861 TO 1865.

Year.	New Works. £	Repairs. £
1861-62	230,031	225,031
1862-63	227,204	235,672
1863-64	223,806	212,651
1864-65	273,523	232,544
Total . .	£954,565	£905,898
Average .	£238,641	£226,474

GOVERNMENT POLICY IN 1866.

The Government of India invite attention to the subject of the preparation of projects for irrigation works, such as would be the most proper to commence upon in the event of funds being made available within the next few years.

4. It will be impossible to provide adequately for the outlay except under the prospect of an early and satisfactory return for the money, so that, ultimately, the necessary funds for the prosecution of fresh works shall be provided out of the profits of those previously completed.

5. It will be safe, as an approximate guide, to say that no scheme of projects should be got up as yet which will require for execution an additional outlay of more than one-fourth of the present budget grant annually.

(Signed) C. H. Dickens, Lieut.-Col., R.A.,
Sec. to the Government of India.
E. C. S. Williams, Captain, R.E.,
Under Sec. to the Government of India.

(Extracts from a Circular Letter, No. 25, addressed to all local governments by the Government of India, P.R. 389, March 22, 1866.)

THREE HUNDRED AND SIXTY THOUSAND POUNDS GRANT FOR IRRIGATION IN 1866.

The sum allowed this year for new reproductive works under the head Agricultural, is very small, being only £383,259. This represents only about £360,000 for reproductive works of irrigation. In the next two or three years the heavy expenditure on gaols and barracks will have been got over.—(September, 1866.)

TEN MILLIONS ON BARRACKS—THEN IRRIGATION WORKS, 1866.

As the outlay on barracks diminishes, we shall be able to transfer the establishments and the annual provision of funds to the execution of works of irrigation for which the arrangements will, by that time, have been matured. But while the provision of improved barrack accommodation for the European troops may be completed at an outlay of ten millions within a period of five or six years, the extension of works of irrigation will demand a much larger expenditure.—(B. B. P. 68.)

1867. LIMIT OF ENTIRE COST OF ANY WORK, £10,000.

The average annual outlay for some years past, on new irrigation works and maintenance, has been about £500,000, and

such a sum at least should continue to be given from the year's revenue, the necessary additional sum only, in excess of this amount, being supplied by loan.

Further, it appears necessary to declare that no works shall be constructed with borrowed money, unless they be of a nature which will admit of the exhibition of the return derived from them, in the form of a cash account of profits on the capital invested.

The limit of entire cost of any work to be aided by loan may, the Governor-General in Council considers, be fixed at 1,00,000 rupees (£10,000), at all events for the present, without unduly burdening the annual grant from the revenues, which may be reckoned at 25 lakhs.

So long as the public expenditure is limited by the annual revenue, the danger of profitless outlay is greatly lessened. With restricted funds the tendency to economical expenditure is strengthened, and thriftless outlay from income is no more than money in possession lost, and profit not made. But to borrow and waste is, not only loss in this sense, but to cause a permanent loss of resources for all future time.—(P.R. 389, 1870, p. 21-22.)

1868. GOVERNMENT PROFESSIONS.

These proposals will be found to afford a safe foundation on which to commence a systematic development of irrigation works in all parts of India on an effective scale; and that a provision will thus, before long, be made for the requirements of the entire country in respect to artificial irrigation.

The increase in the prosperity of the agricultural population, and of the quantity of agricultural produce which must certainly follow the extension of irrigation works, will give a very powerful stimulus to the traffic on the railways; while the increased facilities of transport will largely extend the markets to which such produce can profitably be sent.

We have, &c.,

(Signed) JOHN LAWRENCE.
H. ROSE.
H. B. HARINGTON.
H. S. MAINE.
C. E. TREVELYAN.
W. GREY.

(Extract from Dispatch to the Secretary of State, B. B., p. 31.)

No reliance can be placed on the ordinary revenues for giving effect to such a development of this class of works as is essential for the well-being of the country. The provision that has been made for irrigation works in the Budget estimates for the North-Western Provinces and Punjaub sufficiently attests the truth of this view. For the remodelling of the Ganges Canal an allotment of only one lakh has been made, while the whole estimate is nearly forty lakhs for the works alone.

We have, &c.,

(Signed) JOHN LAWRENCE.
W. R. MANSFIELD.
H. S. MAINE.
W. GREY.
G. N. TAYLOR.
W. MASSEY.
H. M. DURAND.

1869. DECLARATION OF GOVERNMENT.

The same anxious desire to secure to the people of India protection from the frightful calamities arising from drought, has never ceased to animate them, and that the practical benefits of the measures which they have taken, if a sufficient supply of funds can be secured, there is no doubt will soon begin to be realised.

(Signed) MAYO.
W. R. MANSFIELD.
G. N. TAYLOR.
H. M. DURAND.
H. S. MAINE.

(Extract Dispatch, Feb. 8, 1869, P. R. 309, 1870, p. 39.)

SLOW PROGRESS OF IRRIGATION WORKS FROM 1868 TO 1872.

EXTRAORDINARY GRANTS FROM LOANS.

	1868.	1869.	1870.	1871.	1872.
	£	£	£	£	£
Construction .	161,884	328,414	650,207	507,651	708,611
Establishment .	50,322	106,592	162,747	183,618	216,495
Tools and Plant .	7,049	19,843	39,300	65,404	24,723
Increase to Stock .	—	—	62,698	11,535	33,201
	£219,255	454,849	914,952	768,208	983,030

No Expenditure on account of Public Works Extraordinary up to 1866-67.

—(From Statistical Abstracts presented to Parliament, 1873.)

HALF PER CENT. OF LAND REVENUE SPENT ON IRRIGATION WORKS.—BOMBAY PRESIDENCY.

If we now sum up what has actually been done, here is the brilliant record of our energies and enterprise:—

Bombay Presidency.	Total Expenditure. Rs.
Dharwar	84,870
Belgaum	*nothing.*
Sholapore	1,44,241
Sattara	5,96,023
Poonah	*nothing.*
Ahmednuggur	1,94,994
Khandeish	6,40,242
Surat	*nothing.*
Broach	
Khaira	
Ahmedabad	
Poonah	
Rutnagherry	
Canara	
	Rs. 16,61,370

Is it not all but incredible that the result of all the discussions, and exhortations, and parliamentary objurgations of the last twenty years upon this subject of irrigation should be, so far as this Bombay Presidency is concerned, a total expenditure upon such works of about £160,000 down to the end of April 1868. Since the mutiny alone, the revenue realised from the land of the Presidency has been about £35,000,000 sterling. To improve its productive powers by storing the wasted waters of that period, we have made the magnificent expenditure of £160,000—something less than half per cent. of our receipts therefrom.—(*Times of India*, 23rd January, 1869.)

INTERMITTENT FASHION OF PROSECUTING WORKS.

(By Col. Chesney, P.W.D.)

In the early history of the subject, this indecision of opinion and action is indeed very apparent. In Madras, the great irrigation works, although enormously beneficial, and beyond doubt directly remunerative, have been pursued, during the last thirty years, in at least an intermittent fashion; at no time with a vigour commensurate with their surpassing importance. Two canals on the right and left banks of the Jumna, undertaken thirty years ago, were partial restorations of an

old Mohomedan canal. The Ganges Canal was commenced under the influence excited by the great famine of 1838, but the progress was suspended and was not resumed until 1847. The famine of 1861 in the North-west Provinces drew attention back to the subject, and showed both how much had been done towards the mitigation of the calamity, and how much still remained to be done to perfect the natural means of irrigation, available since that event. Some time has unfortunately been lost in discussion as to the best machinery for carring out the needful works. Upon this state of affairs supervened the famine of 1866, but the Home Government has lately sanctioned (?) the proposal of the Government of India to carry out by State agency all needful irrigation works throughout the country.—(Extract from Indian Polity, by Colonel George Chesney, Accountant General, Public Works Department, Government of India, 1868, p. 420-21.)

NO POLICY UP TO 1874.

There is the Damooda Canal, a project brought forward by Colonel Rundall in Lord Mayo's time, the head works of which were said to have been actually begun but *since suspended.* It is said that some of the works have been sanctioned on a very reduced scale, but the entire great work has been deliberately approved, and was only *suspended on account of immediate want of funds.* Its resumption, therefore, at the present moment in its integrity, as a means of giving work, will not only remove immediate distress, but be ultimately of immense future benefit to the country.—(Extract from Sir B. Frere's work on Bengal Famine, 1874.)

WANT OF GOVERNMENT POLICY, 1874.

(Dr. Hunter's Letter to the (London) *Times,* 1874.)

Famines are as preventable in Bengal as they are in England. At present they form the natural penalty for inadequate means of internal transit and for an unhusbanded and uncontrolled water supply. So long as the crops are left at the mercy of a few inches more or less of local rainfall, and so long as vast areas depend on their local harvest as the sole breakwater between the peasantry and starvation, so long will England be called upon to listen to that old, old story, death by famine. As the population goes on multiplying, and as the conscience of

England becomes more sensitive, the cry will be heard with an ever-increasing frequency and intensity. Efforts after the event may mitigate, but cannot avert. *It is a matter for a settled and permanent policy.* Indeed, irrigation is to India far more than roads are to European States; for it does not merely develope the country, but is absolutely necesssary as a safeguard against the most appalling calamity that can happen to the people. The interest on the cost of irrigation and roads is here not simply a price paid for internal progess, but also serves as an insurance rate against famine.

W. H. HUNTER, Author of "Annals of Rural Bengal and Orissa."

Sawant Wari State, Southern Mahratta Country.
February 14, 1874.

1874. BENGAL FAMINE, GOVERNMENT BUDGET.

A general review is now (1874) being made of the whole of her Majesty's dominions in India, as regards liability to famine from the want either of works of irrigation or of means of communication.

Besides a fair surplus of income over ordinary expenditure, such a margin should be provided in addition in ordinary times as shall constitute a reasonable provision for meeting occasional expenditure upon famines.

IRRIGATION STATESMANSHIP! OF THE SECRETARIES OF STATE FOR INDIA, FROM 1865 TO 1874.

(Extracts from Dispatches to the Government of India.)

NOVEMBER, 1865. PROGRESS SLOW.

Works, which spread over a reasonable period would be attended with general benefit, may, if they are all put forward at once, convulse society, and fail, after all, owing to their excessive cost, to obtain the end intended.—(P. 51, par. 9.)

In considering your budget for next year, you will have to determine what amount can be provided from the existing income for works of irrigation,—whether it will be expedient to impose further taxation, or whether the expenditure on all accounts for 1866-67 will require any sum to be obtained by borrowing; and, if this should be the case, it will then remain

to be determined to what extent and in what manner it will be advisable to raise the necessary loan. (Signed) C. WOOD. —(P. R. 105, 1867-8.)

AUGUST, 1866. LOANS WHEN NECESSARY.

There is a marked distinction between borrowing for the prosecution of reproductive works and for the ordinary purposes of Government; and, keeping this in view, I shall not object to a loan being raised for carrying on such works, when the necessity shall have become apparent.—(Page 67, par. 10.)

MARCH 5, 1869. GENERAL PRINCIPLES.

You inform me therein that "the probable outlay that will be needed to carry out the works which are likely to be approved for execution in the next ten years" will amount to about thirty millions, and the sums which will be required in the ensuing years.

As a general principle, when a loan is required, it is desirable that it should be obtained in India, if it can be done on terms nearly as favourable as in England, and it is difficult to decide what additional interest would be counterbalanced by the advantages which otherwise attach to loans raised in India.

NOVEMBER, 1869. RULES TO BE OBSERVED.

I will state briefly the rules with respect to the sanction of irrigation works designed with borrowed funds, which I desire should be observed in future. There does not appear to me to be any sufficient reason for treating such works differently from irrigation works provided for out of ordinary revenue. I propose, therefore, that you should be vested with respect to the former with the same independent powers of sanctioning estimates not exceeding £100,000 each, as you already possess with respect to the latter. All works, however, the estimates for which may exceed £100,000, will continue to require my sanction, and no operations based upon them must on any account, or in any instance, be commenced until that sanction has been obtained.

MARCH, 1874. WANT OF POLICY.

(Speech in the House of Lords, by the Secretary of State.)

Some years ago the Government resolved that irrigation should be carried out on a comprehensive and systematic plan;

but it was found that the plan would involve an expenditure of about four and a half millions a year, and therefore it was felt that all that could be done was to keep up those irrigation works which had been already constructed. My lords, I cannot say that I consider the position of public works in India satisfactory.—(*Times*, March 20, 1874.)

LORD LAWRENCE'S STATESMANSHIP—ASSERTIONS.

(Minute, 26th February, 1864.)

Surely it is a most improvident arrangement making over all the advantages derivable from our magnificent water supplies in India to private enterprise. Those profits under a provident system of management are certain to be large. Water-rent is the one mode of taxation, which, if equitably administered, is sure to be popular. For, for every rupee in this shape, which the State need take, in erder to raise a handsome revenue, we may put at least two into the purses of the agriculturists by constructing a canal. But all this source of revenue is lost when the works are constructed by a private company.

(Orissa Famine Minute, April, 1867.)

I have myself, for the last twenty years, been a consistent and strenuous advocate for such works. I found this question before the Government of India, when I came out as Governor-General, in a forward state for decision. I took up the matter warmly at once, and used all my influence at that time and subsequently, publicly and privately, to press their importance on the notice of the Secretary of State for India. I could do no more.—(April 20, 1867. P. R. 335, 1867, p. 390, par. 28.)

(Minute, 20th February, 1865.)

The revenues of the State are utterly unequal to afford money for such projects; while there are none which could be devised which are calculated in a country like India to produce so much good to the people, while they give security to the present canal revenue, and add to its amount without increasing the weight of taxation generally. I do not anticipate that much can be spared out of the annual revenues under present circumstances, but what we can spare should be annually forthcoming. The capital should doubtless be raised in the English market from year to year.—(P. R. 105.)

(Signed) JOHN LAWRENCE.

CONTRADICTIONS.

(Lord Lawrence's Budget Speech, Calcutta, March, 1868.)

On the question of loans for reproductive works in India, there is a good deal which might be said. Whatever may be the case in the Madras Presidency, I could say, not only in the opinion of an able engineering officer, but from my own observation, that there are few irrigation works on this side of India which will pay, if at all, on a large magnitude, in from nine to twelve years from the time you commence them. If this is the case, or anything approaching it, the case only reflects what a very large debt we should incur by going on, from year to year, constructing works of this kind. I have no doubt in time we should recoup ourselves, but a great many years will elapse. It must also be remembered that during the first two or three years a large expenditure is invested, which is thoroughly of an unproductive character. Surveys and negotiations are required which take up a long time, and demand the services of able and valuable officers, who must be paid in a liberal way. All that money is thoroughly unproductive, and therefore, I would not hesitate to borrow on that account, *if necessary*. I state it as an argument for this Council, that when we have money in hand, we should devote it to meet that kind of expenditure, and should not throw it away by reducing the existing taxation.—(Extract from Budget Speech before the Calcutta Council, published in Summary, *Times of India*, March 28, 1868.)*

("Opinion of an able Engineering Officer.")

The charge for interest, so far as necessary, could be met directly from the loan without the smallest objection. In point of fact, the works to be constructed will actually cost not only the sums directly applied to them, but, in addition, the interest paid on that sum until they become remunerative. *The only essential consideration is whether the works, when constructed, are really worth the whole sum required for them.* Exactly the same thing will be the case if the works are undertaken by a company. The fundamental point, therefore, that requires such careful attention is not, how shall the interest of an Irrigation Loan of 15 or 20 millions be paid, but will the works in the end be really remunerative, allowing for the sum sunk in interest, before they come into full operation. What evidence we have is much in favour of irrigation works properly designed, executed, and managed, proving highly remunerative as an investment of capital.—(Extract from Colonel Strachey's Official Report, pars. 97, 98, B.B., p. 48.)

* See page 301.

OUR NATIONAL SIN.

(By Mr. John Dickinson, Chairman I. Reform and E. I. Association.)

It is the want of policy, and not the want of money, which is at the root of the evil. We saw only the other day how easily the Government might raise capital. I much fear that unless the British nation awakens to a just sense of its duties to India, and a just conception of the intimate connection between our own interests and those of the natives, there will be a continuance of such misfortunes in India. Hundreds of thousands of natives have suffered death by famines alone, because it has been impossible to awake the British public to a thought of their interests.

It is no passing impulse of compassion that will compensate the people of India for this habitual forgetfulness of our duty towards them; no national subscription for a famine fund that will bear any proportion to the mere money loss, much less the loss of life and of human happiness that result from our national sin of neglecting India; and be it remembered, if we gave the natives justice, they would not want our charity.

CAPITAL FOR REPRODUCTIVE WORKS IN INDIA.

EVIDENCE OF MR. SAMUEL LAING, M.P., LATE FINANCE MINISTER OF INDIA.

If the 4 per cent. loan commands a premium in the Calcutta market, would not that lead to the conclusion that people (in India) will lend their money at 4 per cent. or a little over?—Not necessarily; because the price in Calcutta is regulated entirely by the price in London; they know by telegraph, the same day, the quoted value of any India stock in London.

You assume that it is a European market, then, rather than a native market?—Yes, I think so.

But it would be, would it not, politically very advantageous if we could get some of our loans taken up in India, and thereby give the people an interest in the stability of our Government? —Yes; but I do not see how you are to attain the object unless by raising the rate of interest very much higher than you need otherwise. You must wait till wealth accumulates, and the rate of interest has come down in other securities.

If the most authoritative statement was made in spite of the Act which was passed, that if we lose India to-morrow, we should not consider ourselves responsible to pay a farthing of the debt, do not you think that that would produce a great impression on the English mind, and that that statement ought to be made in the most authoritative manner possible?—No; I do not think it would. I think that the English public have invested in Indian securities because they have faith in the duration of our Indian empire, and think that we never shall lose it, unless things are so bad here that probably Consols. would not be much better.—(Extract from Evidence before the P. Select Committee, 1872.)

EVIDENCE OF MR. W. N. MASSEY, M.P., LATE FINANCE MINISTER OF INDIA.

As regards extraordinary public works, such as are supposed to be reproductive, do you lay it down as a sound principle that

the Government may borrow for such works?—Yes, unquestionably. If you can establish the fact that you are going to enter upon works which will pay the interest of the money borrowed, and ultimately the cost of construction, it is a mere commercial operation borrowing the funds; there is no objection to it.

But in those circumstances would you provide that when the works became productive, the revenue from those works should be faithfully applied to the payment of the interest and the extinction of the principal?—Certainly.

Is there any such provision made in the extraordinary public works that have been so executed?—I apprehend there is. When I was in India the system of borrowing for public works began, and there were certain works which were to pay their cost within a very short time, and in respect of those works I borrowed money on short debentures; and it so happened that I paid off one of the debentures in my last year of office.—(Extracts from Minutes of Evidence, vol. ii.)

LORD LAWRENCE'S CAPITAL THEORIES.

I desire to call very special attention to a point which has not yet been looked at in the serious manner it deserves. I refer to the future consequences of the investment by English capitalists of very large sums in India. However we may bridge over in our imaginations the gulf which separates the present from the time when India shall cease to be a dependency of Great Britain, it is difficult to arrive at any other conclusion than that such a time must come. Moreover, it is impossible to avoid the contemplation of a possible period during which the position of a British Government in India may once more be one of grave difficulty. In either of these positions, I would ask, what would be the effect of the investment in Indian Railways of a capital perhaps amounting to one or two hundred millions sterling? So far as India herself is concerned, the question is not important, perhaps; but to England and English interests it is very far from being so. To the Government of India it would, in a time of great trouble, add enormously to its financial difficulties, and possibly entirely destroy its credit. This consideration, however, does not in my estimation legitimately lead to the conclusion that it is therefore improper to accept English capital for the prosecution of great undertakings in India, but only to this, namely, that every

reasonable effort should be made to prevent the permanent accumulation of very large investments of English capital in works or securities essentially dependent on India for their returns. The risk of which I speak, though real, is not of present urgency. Nor, under the circumstances in which India and England are placed in relation to one another, can it be said that the duty of England to assist her dependency is set aside by any superior call to protect herself. For present purposes of profit these investments are reasonable and proper, and cannot be impugned.—(Extract from the Minute of the Governor-General, 16th August, 1867.)

EVIDENCE OF GENERAL STRACHEY, R. E.

I think that it is most desirable that English capital should be employed in the improvement of India. Also, I am distinctly of opinion that it is only by means of English capital that any striking or serious improvement of the means of production in India can be obtained. Further, I am distinctly of opinion that so far as English capitalists can be induced to apply their money in India on terms which are financially satisfactory, even if those terms involved some assistance from the public revenues, any effort in that direction may, with the greatest propriety, be made.

If you consider the general poverty of India (and nobody who has not been in India can really appreciate that), if you consider the total absence of anything like accumulated wealth in India, and if you consider to what an extent wealth may accumulate before the community in India, generally speaking, reaches the sort of position in which European communities are, I think you will be satisfied that a very enormous quantity of treasure and of coin might be thrown into India really without sensibly affecting the prices.—(Extracts from Minutes of Evidence, P. S. Committee, November, 1872.)

INCONCLUSIVE ARGUMENTS OF LORD LAWRENCE.

Lord Lawrence, in one of his minutes, writes:—"The amount which England can supply for Indian investments, without raising the rate of interest, is assuredly limited, and experience seems to show that no great reliance can be placed on India itself for the supply of funds."

If there is any country in the world which can supply the

India, it is England. She has invested money in countries where her flag does not fly; in countries where in politics or finance she cannot move a finger; in countries, also, where internal revolution is not an extraordinary occurrence. The case in India is widely different. The people—the major portion—are docile, divided into at least fifty different sects, speaking as many different languages. At no time can they combine together as a people successfully to drive away the English; the more the people are made happy and contented under English rule, the less probability there is of any internal revolt; and the probability of revolt is now less than ever, seeing that the people are disarmed by law. The mutiny of the native army in 1857 was suppressed before a single soldier from England landed on its shores, and at a time when it took one month to march the troops from Calcutta to Delhi, which can now be done in two days.

In India the finances are entirely controlled by the English Government. The Indian people have no voice in the matter. The English Government can do as it pleases, and so long as its rule is based on justice, and on the welfare of its teeming millions, the country will every year increase in prosperity, and increasing trade between the two countries will bind the tie more closely every year.

As regards the statement of Lord Lawrence, cited above, "that no great reliance can be placed on India itself for the supply of funds," that is but too true. In fact, no reliance ought to have been placed at all, or any calculations made therefrom. It is admitted, and even by Lord Lawrence in his minute, that India is a poor country. It is a well-known fact also that the rate of interest between European merchants or Europeans and natives at the Presidency towns in current accounts is nine per cent. In the interior of India the rate of interest is even much higher. How then can we expect the few rich natives to invest in loans, when they can realise double the interest otherwise in the country itself? In the Blue Book Statistical Abstract for the United Kingdom, we find that the average rate in ordinary times has ranged from two to three per cent. per annum, excepting special years of commercial panics and war with Russia. Since the commercial panic of 1867, the rate of interest of the Bank of England has not exceeded more than three per cent. But the rate of interest is not the question on which alone the policy of ex-

tending reproductive works in India could be reasonably based. The question is, even supposing the rate of interest was more than four per cent., will it pay to borrow at that interest?

INTEREST DURING CONSTRUCTION.

Assuming that the Government will borrow money in the English market (that being the cheapest market in the world) to any extent that may be required, or that may be had, for the prosecution of reproductive works, and that the works will be completed in as short a time as possible—yet a few years must necessarily elapse before the works will be completed and finished, and a general network of canals formed to connect all the principal provinces of India. The Government of India have resolved to borrow to that extent only for which, from the very first year of construction, the resulting charge in the shape of interest on capital borrowed may be met from the surplus revenues. This policy is radically wrong, and quite inadequate to meet the requirements of India. It is unsound for this reason—that the item of interest ought properly to be charged to the capital account, just as much as the cost of materials, labour, &c. When the works are finished, then, and then only, the interest ought to be taken into consideration by itself. Then the amount of interest on total cost, including interest while the works are under construction, subtracted from or added to the nett earnings of the works, will tell its tale plainly enough, to what extent the works pay directly on the capital laid out by the State.

LIVERPOOL DOCKS HOW MADE?

The docks at Liverpool, for instance, have been made entirely out of borrowed money, and the Dock Board have from time to time borrowed money to pay the interest upon their loans, as well as money to complete the works; and when the works were completed, then the revenues arising from those docks were first appropriated to the payment of interest, and after that to the extinction of the debt.

OPEN LOANS.

The Government adopt the principle of borrowing, but unfortunately they give up that distinction between borrowing for investment and borrowing for current expenses, which is the criterion of the expediency of increasing debt. The funds

raised (for reproductive works) might be vested in a Board of Commissioners, whose simple duty would be to see that they were applied to the purpose intended, and to no other. Here we have a fund raised from special sources, for a special purpose, and administered, entirely apart from the general revenues, by a special commission. It does not appear why the funds raised should not be kept apart from the general revenues, under some such organization. If the proceeds of loan are brought to account as part of the ways and means of the year, it will be difficult to distinguish such a loan from a general one, or to prevent the Government from manipulating it to suit the general finances—precisely the rock upon which works have always split hitherto.—(Irrigation in India, Allahabad, 1869.)

GOVERNMENT ATTITUDE MEAN AND COWARDLY.

The refusal to allow the country to borrow money for its reproductive works lest the foreign capitalist should eventually lose it, will by-and-by come to be regarded with shame and astonishment. Under these pretences of concern for the capitalist, there simply lurks the remembrance that as English statesmen have had the finances of India completely at their mercy and under their control, it is necessary to maintain the credit of the country at all hazards, even though we garotte all private enterprise therein, in the struggle to maintain it This attitude of the Government is at once so mean, so cowardly, and so selfish, as to provoke the intensest indignation. There is no country in the world that stands so much in need of capital, or that may borrow it with so much propriety, as this. Ten years ago, Mr. Wilson laid down just as positively the policy of the Supreme Government of that day in the now famous axiom that India must not borrow at all. Five years later, the Government of Sir John Lawrence, when public opinion had become too strong for it, formally withdrew from the position. In spite of its formal disavowal, however, the policy of the State was practically unchanged. The practice of the Government was ostentatiously at issue with its professed conversion to sounder principles. At last, and under the pressure of severe embarrassment, the Government gave tardy and timid expression to its new views, by opening the Public Works Loan of £2,000,000 in 1869. Thus, five years after the date of its conversion to a belief in the wisdom of borrowing money, Sir Richard Temple tells us that the conversion was

partial only; and, for the first time, the Government avows openly what the limits of its conversion are.

During the Bengal famine in 1874, rice was selling at 18 seers the rupee in Nagpore, while it was 40 seers but 180 miles away, over a perfectly level line of country. It is the old story—we must not borrow money, but must wait for a surplus. And so we go on, year after year for years together. The position is simply an infamy.—(*Indian Economist.*)

5,620 MILLIONS STERLING EXTENT OF BRITISH INVESTMENTS.

That comprehensive work, "Fenn on the Funds," estimates that during the two years ending with March, 1869, notwithstanding the severe depression of the period, securities were created in the London market alone representing a capital of £120,000,000. This is no exaggerated estimate when we remember how many foreign and colonial bonds, railway debentures, and miscellaneous shares have been placed before the public. The previous aggregate of investment in all nations is estimated by the same authority at about 5,500 millions, so that the total is raised to 5,620 millions sterling.—(*Money Market Review*, March, 1870.)

400 MILLIONS MONEY WAGES OF THE WORKING CLASSES IN GREAT BRITAIN PER ANNUM.

Generally, we may say, two-thirds of the population are working classes, and their number may be taken as twenty-one millions. In my report a few years ago I stated that the total amount of the wages and earnings of the working classes might be taken at £414,000,000, of which the money wages would amount to about £350,000,000. Since then there has been an increase of wages and an increase in the number of workmen, and we may calculate that now the money income will amount to £400,000,000 annually.

The proportion expended on each article by the working classes may be approximately stated as follows:—Per cent., bread, 15; flour, 5; meat, 7½; butter and cheese, 5; sugar, tea, and coffee, 6; other articles of food, 6½; drink, 12; tobacco, 3; rent and taxes, 9; coal and gas, 6; clothing, 13; sundries, 12; total, 100 per cent.—(From Professor Leone Levi's Report.)

WHERE LOANS FOR REPRODUCTIVE WORKS IN INDIA SHOULD BE RAISED.

THE DUKE OF ARGYLL'S VIEWS.

As a general principle, when a loan is required, it is desirable that it should be obtained in India, if it can be done on terms nearly as favourable as in England, and it is difficult to decide what additional interest would be counterbalanced by the advantages which otherwise attach to loans in India. It is when loans are obtained in India that the native capitalists subscribe to them. Moreover, when loans are raised in England the interest must be paid here, and this adds to the very large sum (about £13,000,000) which must be remitted annually to meet the disbursements in this country, and which must increase as long as payments are made in the Home Treasury by the railway companies. According to the most recent returns, the prices of Indian Government Four per Cent. securities in India and London were as follows :—Four per Cent. securities, India, 4th January, 1869, 94½ rupees; London, 12th February, 1869, £102½; being at the rates of interest of £4 4*s*. 8*d*. and £3 18*s*. 1*d*. per cent. in India and London respectively.

Having regard to the comparatively little difference in the value of securities in India and in England thus shown, to the political advantage which attends borrowing in India, and to the fact that the interest of such loans is paid without the inconvenience or risk of remittance, it appears to be desirable that you should obtain in India as large a portion as practicable of any loans which may be required.

I cannot accede to any proposition for borrowing a specific amount in the next five or six years. The amount must, however, be determined from year to year. It would obviously be inexpedient to make public the intention of borrowing largely in future years, as such an intimation would immediately affect the money markets, and any estimate now made might require considerable modification before the commencement of another year.—(Extract from Despatch to the Government of India, signed ARGYLL.)

ENGLISH MINISTRY AND INDIAN LOANS.

A more mean or unworthy policy was never followed by one nation towards another than that which the English ministry

has deliberately adopted towards India. As the whole world knows, the so-called Indian debt of £100,000,000, from the way in which it has been built up, would be promptly declared an English liability in any court of equity in the world. It is an English debt from beginning to end, incurred by a dishonest trustee in the name of his ward for purely personal advantages of his own. Having considerable misgivings as to the proper incidence of this debt, and India's power to sustain it, it is now discovered that the right policy is to lay down the maxim that "India must not borrow." While all other countries of the earth may borrow as freely as they please of English capitalists even for war purposes, India, the poorest of them all, whose fortunes God has given into the hands of the wealthiest nation of the world, is to look to her taxes for the construction even of the roads and tanks, for want of which the people, by reason of famine, periodically perish by millions.

We have been ready enough to borrow in India's name for the conduct of the wars we have forced upon her, that we might evade their cost, but to borrow for purposes that may rescue her own children from perishing of famine is not to be heard of. The principle we have ever contended for is simply that works of a reproductive nature should be constructed from capital borrowed in the cheapest market, while Government has laid it down that "India must not borrow."

While her people are perishing by millions from constantly recurring famine, we take from her treasury two-thirds of a million sterling to put up a palace in Downing Street, and a million more to build a magnificent transport fleet in our dock-yards. India may not borrow, every other nation may. And yet look once more at their respective positions. India then has an existing debt of 13*s.* 4*d.* per head of population. This debt, moreover, is not hers but England's, but for the argument we assume it to be hers. Indebtedness of nations, per head of population:—India, 13*s.* 4*d.*; United Kingdom, £25 16*s.*; France, £32; Holland, £13 1*s.* 4*d.*; United States, £17 15*s.* 5*d.*; Portugal, £9 11*s* 6*d.*; Austria, £6 14*s.* 10*d.*; Italy, £7 19*s.* 5*d.*; Switzerland, £10 4*s.* 6*d.*; Greece, £9 15*s.* 5*d.* And she of all these lands may not borrow at all, although if we will but give roads and water to her estate, we shall increase the capitalised value of her property by a thousand millions sterling. We have pottered with the question like

selfish cowards all these years, and are pottering over it still.—(*Indian Economist*, May, 1871.)

GIVING INDIA A STONE INSTEAD OF BREAD.

You have in your wisdom given the country a system of high-cost and high-speed railways in advance of its wants, *for purely military purposes*, and in the teeth of twenty years' protestations that these railways are *not* what the country requires —viz., means of carrying cheaply to the coast the produce of the interior. Surely there never was such perversity on the part of a mere trustee. All you think of seems to be your own safety, and the contingency of your own possible but most remote liability. You not merely refuse to guarantee Indian loans, but affect that it is your duty to hold back the English capitalist from advancing the funds which he is ready to give but for you. What have you to do with the matter at all? Are the capitalists of Europe unable to judge? The people of this country must have communications, and have them upon the cheapest terms if they are to grow prosperous. They have asked you for bread all these years, and you have given them a stone; and you now tell them to get bread at five times the price they can buy it for, if you will but stand out of their way. Your railways, as you know, are military works more than anything else, and in offering them to the people in answer to their cry, you are offering them a stone, and not bread. During the last twenty years you have shut India completely off from all access to the capitalists of Europe, while the country is destitute of the commonest means of communication, and can make them for itself only at enormous cost; and you now reproach it with the fact that its wealth increases so slowly that you think it necessary to forbid English capitalists to assist it with their means! Whose fault is it?—(Extract from a paper read before the Calcutta Social Society by Mr. R. Knight, now Secretary to the Government of Bengal.)

INDIA IS A POOR COUNTRY.

India is, on the whole, a very poor country. The mass of its people enjoy only a scanty subsistence. They are impatient of taxation, except where it is of that peculiar nature to which they have long been accustomed. The tendency of new modes of taxation is to irritate, and even to oppress. We ought to

avoid, so far as may be practicable, such fruitful causes of discontent.—(Lord Lawrence's Minute, March, 1864.)

STATEMENT OF THE UNDER SECRETARY OF STATE.

Here you have a comparatively wealthy population. The income of the United Kingdom has, I believe, been guessed at 800 millions per annum. The income of British India has been guessed at 300 millions per annum. That gives well on to £30 per annum as the income of every person in the United Kingdom, and only £2 per annum as the income of every person in British India.—(Speech, Mr. Grant Duff, in Parliament, 1871.)

MINUTE OF THE HON. H. M. DURNUD.

It is futile to look to native capitalists, or to the impoverished services of India for a large loan, and heavy general taxation for such local purposes is not equitable. Irrigation works should bear their own burthen, and ultimately clear themselves. Loans raised in England, and applied under the control and the responsibility of Government, are the cheapest and the most certain and unexceptional mode of securing, with a minimum of pressure on the Indian tax-payer, the means for the construction of reproductive works.—(P. R., 105, 1867, p. 65.)

OPINION OF MR. ANDREW CASSELO, RETIRED MERCHANT, NOW MEMBER OF INDIA COUNCIL.

It certainly seemed very strange that semi-bankrupt states, like Turkey and Egypt, should get money from this country, that we should lend to states whose chronic condition was one of revolution, like Peru, and yet we should virtually shut out our own great Eastern Empire from the market. If the reason were, as had been stated, the fear that India would one day be lost, and that when that evil day came the less we had to lose the better, all he had to say was, that the present system was best calculated to bring about the very consummation which was dreaded. During the last few years, there had been deficits on the Indian budgets amounting to upwards of six millions sterling, but of these, three and a half millions could be accounted for by the expenditure on barracks alone. In order to cover these deficits of our own creation, the people of India

were exasperated by the imposition of unnecessary taxes, especially an income-tax (the most odious of all taxes in their sight) equivalent to 7*d*. in the pound sterling.—(Discussion, East India Association.)

OPINION OF MR. DADABHAI NAOROJI, MERCHANT, LONDON.

Let Government open loans at 3½ or 4 per cent., both in India and England, at the best prices capitalists would give for this interest, and in such a way that the notes be easily negotiable both in India and England, and that the interest may be also obtainable in both countries without unnecessary trouble, and the natural laws of capital will settle the rest. If the English public have confidence enough, and if the 4 per cent. sterling loan is now at a premium, why should the Indian Government not allow India the benefit of these loans, and the capitalists of England an investment under the control of the British themselves?

If India is able, by all means raise the loans there. But India does not at present produce enough for its ordinary wants, much less can it save or spare capital for these loans. The very fact that capital is worth 9 per cent. ordinary interest in India shows its insufficiency, even for its very limited commerce. The most obvious remedy for the very poor production of the country, and its extra-political wants, is to increase production and facilitate distribution. It is no discovery of mine Irrigation to increase production, and cheap communication, are the crying wants of a country like India.—(Address before the E. I. Association.)

"HOARDINGS OF NATIVES."

Capital they can hardly be said to have. When I used the phrase hoarding money, perhaps I gave you to understand that the sums were considerable. That is really not the case; the sums of money hoarded are something exceedingly trifling, I believe. Now I have cultivated fields myself, to see what can be got out of the soil, and after cultivating them, and paying the expenses, I found the residue left over for the farmer so small, that I let my rice lands around my coffee plantations for nothing. I just take the Government due, and pass it on to the Government. So that when you come to examine the sources from which these hoards can be derived, you will be

able to come to a conclusion how very slight these hoards must be; it is merely a general name.—(Evidence of Mr. R. H. Elliott, 1872.)

"THE TIMES."

Why is India, notwithstanding its fabulous reputation, one of the poorest countries in the world? Because it is in want of highways, ports, navigable rivers, systems of irrigation, and arrangements for developing its agricultural and mineral wealth. Why is France a rich country? Because for ages its rulers have been occupied with the creation of these very treasures. With good communications, easy means of transport, a fertile soil, accumulated materials, and an industrious population, a nation is necessarily wealthy.

"WESTMINSTER REVIEW."

India does not want immigrants from England, except as directors of her industry: she wants our capital and our knowledge. The nature of her climate, if only irrigation be afforded, puts her on a par with the possessors of a virgin soil. Hitherto India has poured in upon England, in the shape of pensions and miscellaneous payments, more capital than can be proved ever to have been advanced to her. If now an opposite current set in—such as would not be possible were not Queen Victoria Empress of Hindostan—the new process will be more natural and reasonable, more beneficial to both countries.

A TEST OF INDIA'S POVERTY.

The total number of incomes assessed in the Punjaub in 1870-71, the tax descending as low as £50 a year, was less than 43,000 out of a population of 17 to 18 millions of persons, the result being that the tax, which was $3\frac{1}{8}$ per cent., equivalent to an income-tax of 8*d.* in the pound, yielded no more than £150,000. Now at home such a tax would have yielded eight millions sterling. It was found that there were but 43,000 assessable incomes in the whole Punjab, and of this number 33,435 were below £100 a year. The exact statistics are: Incomes, £50 to £100 a year, 33,435; incomes, £100 to £1,000, 9,007; incomes above £1,000, 135.

The Administration Report from Bengal for the same year tells precisely the same story:—Throughout the whole of the Lower Provinces, with their 40 millions of people, the general

poverty is such that only 21,000 incomes were returned at about £100 a year to Mr. Wilson's income-tax, and only 64,000 at more than £50 a year. Under the $3\frac{1}{8}$ per cent. tax of 1870-71, which goes down to £50, the total number of assesses were less than 128,000, more than half of whom are in class 1, the lowest of all.

The returns for all India, with its 130 millions of people, under Mr. Wilson's income tax, were.—53,000 incomes of £100 and upwards; 141,500 incomes of £50 to £100; 500,000 income of £20 to £50.—(From *Indian Economist*, February, 1872.)

A TEST OF ENGLAND'S WEALTH.

The following are the amounts of the annual profits assessed in Great Britain. Incomes under £100 are not assessed. On the earnings of the working classes, estimated at 400 millions sterling per annum, no income-tax is levied. The Earl of Shaftesbury, in July, 1874, in opening the Park Estate, containing model houses for the working classes, stated that he found that the wages of the working classes in England could not be less than 400 millions a year:—

	£
1857	313,056,427
1858	327,138,852
1859	328,127,416
1860	335,188,318
1861	335,654,211
1862	351,745,241
1863	359,142,897
1864	371,102,842
1865	395,828,680
1866	413,105,180
1867	420,773,568
1868	430,368,971
1869	434,803,957
1870	444,914,228

GOVERNMENT PLEA FOR KEEPING ENORMOUS CASH BALANCES.

The cash balances ought simply to represent, from one month to another, an intelligent and satisfactory provision for the maturing liabilities of the State, not for all its liabilities. The maintaining of these balances at the absurd height has been a mere sacrifice of means, a manifest economic error. The liabilities of Rothschild, or of the Oriental Bank Corporation, are

probably twice those of the Government of India at any given moment, but what would either of those great institutions say to allowing 15 to 20 millions sterling to lie idle in their hands for twelve months together? The State might have been receiving for many months past 4 per cent. upon six to seven millions sterling of their balances, had they been properly administered.—(*Indian Economist.*)

HOW TO MAKE USE OF INDIA'S CREDIT.

When the Government once awakes to the fact that it is to a courageous use of the national credit we must look for the means of constructing the great works of improvement that wait execution in our midst, a new era will have dawned upon the country altogether. We shall have discovered the secret of the vast progress of other lands, notably of the United States. Poor as India is, by a right use of her credit, she has the means of supplying all her material wants as readily as the wealthiest nation upon earth. She may borrow as much capital as she pleases at 4 per cent., for works, the reproductive power of which in creating new wealth will simply be incalculable For a nation to borrow money that it may expend it upon luxuries, or upon military establishments, is purely evil; to borrow it for works of material improvement is all but purely good — (*Indian Economist,* 1870.)

CAPITAL PROPOSALS, MADE A QUARTER OF A CENTURY AGO, IN AN OFFICIAL REPORT.

Whether the present surplus of revenue over expenditure be large or small, we would contend against the principle of making the accidental amount of that surplus the measure of the expenditure on improvements morally certain to produce an increase of revenue by the legitimate and really beneficial means of augmenting the comfort and the resources of the people. Such a debt cannot be regarded at all as a burden on the finances, because it is morally certain that the investment of the sum borrowed will create a fund for its repayment. Good credit, as the fruit of stability and good faith, is one of the advantages enjoyed by a good government over a bad one, a government which possesses it and fails to make use of it, willingly surrenders one of the most important advantages resulting from its position and character. People do not act thus in private life. A merchant values his credit as a part of

his capital, it stands to him indeed in the place of capital, and, if judiciously employed, equally yields a profit. Such loans need not form a permanent burden on the finances, but may be accompanied in every case by provisions for their gradual liquidation: either annuities for terms of years might be granted, or, which would perhaps be better, the increase obtained from the particular works, or from the particular tracts or districts affected, might be devoted to the liquidation of the debt as the primary security, the general revenue to be of course the ultimate security in case that first should fail.—(B. B., Report on Public Works, Madras, 1853.)

LABOUR FOR REPRODUCTIVE WORKS.

SIR CHARLES WOOD'S IDEAL DIFFICULTY.

Works which spread over a reasonable (?) period would be attended with general benefit, may, if they are all put forward at once, convulse society, and fail after all, owing to their excessive cost, to obtain the end intended.—(Extract from Dispatch to the Government of India.)

REPLY TO SIR CHARLES WOOD'S OBJECTIONS.

(By Sir W. Mansfield, Member of Council, Calcutta.)

Had such reasoning been admitted, we should not now have a mile of railway in the country. The progress of all such works must adapt itself to the means for supply of labour. The process is self-adjusting, and does not anywhere lead to convulsion, except, perhaps, in the development of a colony which discovers gold mines.—(W. R. M.)

LABOUR OBJECTION ANSWERED IN 1853.

The fear of a want of labour appears very singular. Such an apprehension is ideal. It receives a practical refutation in all the instances that we have cited of the profitable result of irrigation works, but other proofs may be brought forward; the people of this country are proverbially averse to change, and disposed to endure suffering rather than seek relief in new spheres of exertion; yet, every year, several thousands leave their native land, their families and homes, and go to the Tennasserim Provinces, the Mauritius, and even the West

Indies, attracted by wages which do not appear very high. So also there is every year a regular migration of labourers from the mainland to Ceylon, at the coffee-picking season, and nearly the whole of this is from Tanjore, the very province in which for many years there has been a larger public expenditure, both on roads and irrigation works, and greater extension of cultivation has taken place, than in any other. Again, within this country, we find no undertaking delayed for want of labourers; the Hussanoor Ghaut, though in a very unhealthy country, was thronged with people anxious for employment, and the same with all the passes in the western ghauts; and the sudden demand for the great works at the Godavery was immediately responded to, and at first people crowded to the works in far greater numbers than they could be employed. In all these cases it has been abundantly proved that the one condition necessary to obtain command of labour is punctual payment; a higher rate than two annas (3*d.*) daily has never perhaps been paid for unskilled labour, but this is found quite sufficient if paid punctually and in full. The readiness with which labour is supplied whenever wanted, without deranging other employments, and its very low rate of remuneration, convincingly prove its abundance; and we are painfully convinced that the great want of this country is not labour, but the very contrary, employment for labour.—(Report of the Commissioners, P. Works, Madras, 1852, B. B. 407, 1853, p. 125.)

BROAD POLICY IN 1870.

The fourth line upon which our financial policy should be built was the pushing on, with the utmost zeal and to the fullest extent to which it could be done *without deranging the labour market*, all public works which would be directly remunerative, while we rather held our hand, which was not directly remunerative.—(Budget Speech of the Under Secretary of State in Parliament, August 10, 1870.)

WAGES IN MADRAS IN 1872.

In this part of India manual labour is as little costly as bullock labour, and that even for ploughing the heaviest kind of agricultural work, we can, on such soils as we have in some parts of the Madras farms, plough with men as cheaply as we can with cattle; while on the roads men can, in drawing carts,

compete successfully with horse or bullock labour. Three men can be hired to perform a day's work for a shilling.—(Extract from the Official Report of the Superintendent, Madras form, 1872.)

COST OF LABOUR IN OUDE IN 1870.

The ordinary rate for skilled labour appears to be 6*d*. a day; for unskilled, 3*d*. a day. That life can be supported on so small a sum, shows alike the fertility of the country, the temptation to the population to increase, and the cruel inequalities in the distribution of wealth.—(B. B., M. and M. Progress of India for 1870, p. 42.)

COST OF LABOUR IN PUNJAUB IN 1870.

Wages varied little, if at all, during the year. Taking the average of all the towns, the highest skilled labour commands 11¾*d*., the highest unskilled labour 4¾*d*. per diem. Cart hire averages 3*s*. 8*d*. per day, a camel about 10½*d*. per day, and a score of donkeys, 6*s*. 10*d*. per day. The province possesses sandstone, granite, and other kinds of stone useful for building purposes, in abundance, also marbles, limestone, and gypsum, extensive slate quarries, and petroleum.—(B. B., Progress Report of India, 1870, p. 60-62.)

WAGES IN INDIA IN 1872—OFFICIAL REPORT.

In the Punjab, wages range from 1*s*. to 6*d*. a day for skilled, and 6*d*. to 2*d*. a day for unskilled labour; and there has been a steady rise in the price of grain.

In Oudh they are only 3*d*. for skilled and 1½*d* for unskilled labour a day.

In the Central Provinces skilled labour fetches 1*s*. to 6*d* a day, and unskilled 3*d*. to 1½*d*.

In Mysore and Curg the wages range higher, by the proximity of the coffee plantations of Curg and Wynaad. The pay of an unskilled labourer in Mysore ranges in some places as high as 6*d*.

In the Bombay Presidency wages are much higher, from a variety of causes; a skilled labourer receives from 2*s*. to 8*d*., and an unskilled labourer from about 6*d*. to 3*d*. a day; and the price of rice ranges from 14*s*. to 7*s*. a maund. Famine prices ruled in part of the Deccan towards the end of 1871. Fever is by far the most prolific cause of death in India. The

total number in all India cannot be far short of a million and a half. At least half these lives might be saved if we could put quinine retail into every native druggist's shop at 1 rupee per ounce. It is the only real remedy, and the people believe in it, and are ready and anxious to take it. The vast importance of the introduction of chinchona cultivation into India cannot, therefore, be over-estimated; and there is now every prospect of being able to manufacture at the plantations at a cheap rate, and conferring a priceless boon on the people.—(B. B. Progress and Condition of India, 1871-72, p. 100.)

WAGES ON FAMINE-RELIEF WORKS, 1874.

A careful note relative to the rate of wages on relief works had been prepared by Colonel Nicolls, the chief engineer.

South of the Ganges, in Shahabad, Patna, South Monghyr, South Bhaugulpore, the rate for a single man was from one anna and six pies to two annas per diem, and for a man, wife, and child from three annas to four annas per diem. To the north of the Ganges, the rate for a man was from one anna to two annas, and for a man with his wife and child from two annas and one pie to three annas and seven pies.—(B. B., Bengal Famine, 1874, p. 45.)

SCHOOLMASTERS' SALARY TEN SHILLINGS A MONTH.

In the North-Western Provinces in 1865-66, in low-class schools, 155,255 pupils were taught by masters receiving from three to five rupees (10*s.*) per month.—(Note of Sir Alexander Grant, Director of Public Instruction, Bombay.)

ARE WORKS IN INDIA CHEAP OR DEAR?

So far as work is more costly in India than it is in England, it is merely that certain classes of materials are more costly; for instance, taking our railways, the whole of the iron, before it is put in the railways, costs about double what it does here. Other public works are much cheaper, not dearer.—(General Strachey's evidence, before the P. Select Committee, 1872.)

WORKS IN INDIA AND ENGLAND.

In India good ordinary brickwork will cost 40*s.* per 100 cubic feet; ashler, about 2*s.* per cubic foot; timber work, 7*s.* per foot wrought and put up. A work costing £10,000 in

India would cost £40,000 in England.—(Col. Medley's Indian Engineering, p. 60.)

COST OF STORING WATER.

The expense of storing water is proved to be inversely in proportion to the extent of the reservoir. The lowest price for works constructed on this principle in England has been *3d* per cubic yard; but in India, where much larger areas are available, it has been as low as one-tenth of a penny per cubic yard To obtain a fair profit on the outlay, the works must be carried out on a grander scale, on rivers having large catchment basins.—(B. B., M. & M. Progress of India, 1870, p 49)

WHAT A HINDOO NAVVY COULD DO.

One and a half cubic yards of earth per diem used to be considered a man's work in excavation under the old rules, and people fancied the Indian labourer could do no more on account of his slight frame and feeble physique So far from this being the case where the system has been tried of paying by measurement, viz., so much for every cubic yard excavated, the average tale of work is not less than four cubic yards per diem, and five or six yards is by no means unusual in cuttings averaging a yard deep. Again, palankeen-bearers, who are paid by the distance, think nothing of carrying a traveller from twenty to twenty-five miles at a stretch, and are known to do more. There is, indeed, great endurance and perseverance in the Hindoo, when he feels himself at home in his work: his vision, indeed, is limited; he is slow to see prospective advantages, if at all of a novel description.—(Col. Greenway's Farming in India.)

MEANS FOR IMPROVING LABOUR.

The physical powers of the Indian workman are capable in many instances of being augmented by means of better food than hitherto has been accessible to him. Contractors for Indian railways have found that labourers entering their service in the ill-nourished condition arising from feeding on inferior descriptions of grain, come to develop considerable increments of strength and endurance under the generous diet which good wages enable them to indulge in. Instances of this kind are specially frequent among Mussulmans and the less rigid sectaries of Brahmanism, who without hesitation eat animal

food, as well as other things considered unclean by a high-caste Hindu. So that we may well look forward to a corresponding progress in the bodily strength of the people.—(*North British Review*, March, 1869, p. 242.)

DENSITY OF POPULATION IN INDIA.

Per square mile: Bengal, 430; Bahar, 465, Orissa, 180, Assam, 63; Chota Nagpore, 87; Lower Provinces, 290; North-West Provinces, 380; Oude, 465, Punjab, 173, Central Provinces, 108; Berar, 132; British Burma, 27; Madras, 220; Mysore, 187; Curg, 84; Bombay, 110. The total population in India is 250 millions; the total area, 1½ million square miles.

NUMBER OF LABOURERS REQUIRED FOR CANALS.

The sum proposed for combined irrigation and navigation canals amounts to £400,000 per each district in India, and could be expended, without disturbing the labour market in five years, requiring about 12,000 labourers, out of a population of each million. How can there possibly be any question about this work being undertaken after what the Government have found themselves able to do about railways?—(Sir A Cotton)

GOVERNMENT DELUSION.

The Government assign as one of the main reasons for going on with the works gradually, that they do not wish, on economic grounds, to disturb the labour market. The authorities, from the tone of their dispatches, appear to dread a rise in wages even more than a famine. But what does a rise in wages mean? This—that the poorest classes will earn a little more than they do at present, which is 3*d* a day. The item of labour, even if it be high (which it is not), ought not to be regarded as the sole basis to determine the policy of extension of reproductive works The rise in wages ought not to form a bar, or be brought forward as a reason for going on with the works of regulating the waters in India gradually, and not pushing them vigorously with all speed. The sooner the works are commenced, and the sooner finished, the better. Delay and procrastination will only increase the cost of works. The question of finishing the works as soon as practicable is so urgent, and there are so many weighty reasons for doing so, that it ought to be done quickly, even at the disadvantage of

paying a higher rate of wages. By pursuing this policy, and showing real energy and speed, no one will be a loser: in fact every one will gain by it. Even the assumed disadvantage of a rise in wages will vanish, and in a short time tell its true story, in the increased consumption of salt, articles of food, piece goods, and an increased revenue to the State.

BUILDING MATERIALS IN INDIA

(By Lieut.-Col. J. G. Medley, R.E., Principal Roorkee College.)

Stones—There are many varieties in different parts of India, and it is employed in the various forms of ashlar, rubble, &c., very much as it is in Europe. Granites, limestones, and sandstones are extensively used in the localities where they occur, but the cost of carriage over bad roads to distant places necessarily restricts the employment of this material In Southern India, laterite, a clay-stone, is extensively used, being easily worked, and becoming hard by exposure to the air. In Upper India, Delhi and Agra are famous for their red sandstone, and Jeypore for its white marble, of which the Taj and other famous buildings are constructed. Bombay has also many varieties of stone, notably the Poree-bunder limestone. Allahabad has some fine quarries of sandstone.

There is a kind of soft stone, called moorum, found in Central and Western India, which, though almost useless as a building material, is extensively employed for road-metalling. Kunkur, too, is quite an Indian speciality, though it is almost entirely confined to the North-Western Provinces. It is a peculiar kind of oolitic limestone, found in beds just below the surface, and is of two kinds. one adapted for building purposes, in which it strongly resembles artificial concrete; the other answering admirably for road-metalling, for which purpose it is broken into lumps about the size of an egg, drenched with water, and then rammed until perfectly smooth, after which it is allowed to dry before the traffic comes on it The manufacture of artificial stone by Ransome's process has been tried at Bombay on a small scale, but not with success in an economical point of view.

Bricks.—In the greater part of Upper India, and over much of the rest of India as well, brick is the chief building material.

Good ordinary bricks are procurable in India, if only proper care be exercised, and a fair price paid for them. The common native brick is very small, and laid in quantities of mortar with little care about bond; so that native walls are really masses of concrete.

Hollow bricks are never seen, I think they would be found to be much cooler in the walls of buildings than solid bricks.

Coloured bricks are nowhere used in India, and their absence is much to be regretted, for they would be most useful both for architec-

tural ornamentation and for floors and similar purposes. The proper clays, on which the colours depend, are found in some parts of India, and careful search would doubtless bring to light others Here we are met by the fact that their manufacture requires skill and capital. The same remark applies to terra-cotta and encaustic tiles, which would be admirably adapted for Indian use, and would, moreover, stand much heavier transit charges But the Government cannot be expected to enter the field as manufacturers, and so we must wait for English capital and skill, or for the progress of native enlightenment.

At Akra, near Calcutta, there is an extensive Government brick-field. Hoffman's kilns have been lately tried, but not very successfully. It would not pay to carry bricks far, and Indian distances are long. You cannot afford an expensive construction, however good in itself.

Bricks are burned in clamps and kilns, but it is only in the neighbourhood of the very few coal (developed) localities in India that coal fuel can be used, you will generally have to use wood, or in the case of clamps, dried cow-dung and stable litter, commonly called *oopla*.

Brick arches are laid, as in England, either in half-brick rings, or, in important works, with the bond carried right through the arch. The natives are very skilful in constructing centerings. For large arches, whether built with regularly framed timber centres or the common native centres, the French fashion of striking them by means of hollow iron cylinders filled with dry sand, supporting pistons on which the laggings rest, has been largely employed of late.

Masonry made of brick or stone laid in lime-mortar is everywhere called *pucka* masonry. Sometimes sun-dried or unburnt bricks are used, in the case of cheap buildings, for interior walls, or in districts where the rainfall is scant, for exterior walls as well, this is *kucha* masonry.

The *Tiles* generally used in Government buildings are known as the Goodwyn and Atkinson pattern tile. The hexagonal hollow tile introduced by Colonel Fife for roofing purposes (and known as the Sind tile), is worth attention; also the drainage tiles made by Captain Jeffreys for the Ganges Canal

Slate is generally scarce and inferior, but some fine quarries have lately been opened out at Dalhousie, and in the Khuttuk Hills, in the Punjab.

Limes and Cements.—Lime is obtained in India from the limestone boulders found in hill torrents, from kunkur, from beds of marl, or rather calcareous tufa, and from limestone *in situ*. It is burnt with wood fuel, generally in conical kilns, and is mixed with sand, burnt clay, or brickdust, to form mortar in the usual way. The best lime is that procured from boulders, which when mixed in the proportion of one part lime to two parts of *soorkee*, or pounded brick, forms an excellent mortar for hydraulic works. Kunker lime, as a rule, is simply mixed with sand. When lime is burnt with *oopla*, care must be used in separating it from the ashes of the burnt fuel. The mortars employed, in Upper India at least, are excellent, if only proper care be used in their preparation. What is chiefly required is a very quick-setting cement or mortar which, even when used in

building in water, shall harden in one or two days. This is much wanted for repairs to canal works

Lime is also used in stuccoes and plasters much as in England Madras is noted for this work, where the very beautiful *chunam* plaster for interiors of rooms is as smooth, hard, and polished as marble.

Concrete is not very much employed in India, though it has attracted attention lately. some of the works on the new Sirhind Canal were designed to be built almost entirely of it, such as arches of forty feet span. Indeed, with an abundance of excellent lime, and a great scarcity of fuel, it seems curious that it has not been more extensively used.

Timbers.—There is an immense number in India occasionally used; but practically restricted to a very few varieties, which are procurable in any quantity. In the Punjab, for instance, the Deodar (*Cedrus deodara*) is the principal wood employed, being nearly identical with the famous cedar of Lebanon It is found in the Himalayan forests, where it is cut, thrown into the rivers, and left there till the succeeding rains swell the stream and carry the logs down below, when it is rafted and floated into the plains. It is a very valuable timber, procurable in great scantlings, and used for every purpose: trees of seven, eight, or nine feet diameter at the foot, and seventy feet long, are by no means uncommon. In the North-Western Provinces the saul (*Shorea robusta*) is the principal tree; it has a long, fibrous grain, is straight and strong, of a reddish colour, and very valuable for all purposes.

In Burmah and Western India, the teak is the principal wood. Its many excellent qualities are well known. Other common timbers are the mangoe, used only for planking or furniture, and readily attacked by insects, the sissoo or sheeshum, a hard, strong, but crooked wood, in request for furniture, as it takes a beautiful polish, the keekur or babool, an acacia, a very hard tough wood, much used for carts. The native carts or hackeries are drawn by bullocks or buffaloes, and are exceedingly primitive vehicles. They have no springs, often no iron tires to the wheels, but the advantage is that they can go over any rutted track that does duty for a road.

Timber in India is generally seasoned by the air or water process, and is occasionally kyanised or Burnettised. Well-seasoned timber stands the climate well if carefully protected from white ants. The best preservative is carefully to prevent any earth or mud from coming in contact with it. Wooden posts buried in the earth will very soon be useless. Indian carpenters are generally very fair, and sometimes very clever workmen

Metals.—Iron is nearly all brought as pig from England. There are valuable iron, copper, and other ores in India, but the great cost of fuel and of carriage has hitherto prevented their being worked extensively A good deal of native iron is certainly brought into the market, and worked up into tools, straps, bolts, &c., iron roofs and bridges even, those made at the Roorkee workshops being manufactured from English iron.

Wages, of course, vary more or less, but the pay of a common labourer all over India may be fairly set down at 2 annas, or 3*d.* a day,

of an ordinary mechanic at 6*d.* to 7½*d.*, with which he finds himself in everything. A *beldar*, or navvy, will get 4½*d.*, and a skilled carpenter or mason from 9*d.* to 1*s.* a day.

Cost of Works.—Good ordinary brickwork will cost about 40*s.* per 100 cubic feet, ashlar about 2*s.* per cubic foot, timber work 7*s* per foot, wrought and put up.

A work costing £10,000 in India would cost £40,000 in England.

The European overseers are nearly all non-commissioned officers or privates who have volunteered from the various regiments in India for the Public Works Department, and have been trained at the Roorkee College. As a rule, they are hard-working, intelligent men, and many of them are most valuable subordinates, but they are generally deficient in practical knowledge, are not very conversant with the language, and are but too often given to drink The native sub-overseers have also been trained at Roorkee, and are generally good draftsmen, surveyors, and estimators, but have no practical experience, and lack physical stamina. The Mistrees, or native head-masons and carpenters, are generally intelligent and good men, quick to learn and easily managed, but few have any theoretical knowledge The native labourer is patient, docile, and lazy.—(Extracts from Indian Engineering.)

ENGINEERS FOR REPRODUCTIVE STATE WORKS IN INDIA.

THE NEW ENGINEERING COLLEGE IN ENGLAND.

EVIDENCE OF LIEUT.-COL. GEORGE CHESNEY, R.E., PRESIDENT OF THE COLLEGE.

Outlay.—The purchase of the buildings and estate was made in January, 1871, and the college was opened in August, 1871. The purchase of the estate cost £55,000; the additional outlay for buildings, including residences for five professors, has been about £28,000: about £10,000 for furniture, fittings, scientific apparatus, workshops, and other appurtenances, the outlay will be £93,000.

Receipts.—The annual charge is £1,502, which from 150 students will give an income of £22,500.

Expenditure.—The establishment is estimated to cost £19,000 per annum, not including the interest on the capital laid out. The salaries of professors, £6,481, is included.

Course of Study.—The full number of students to be accommodated is 150, who will go through a course of three years' study, the first two years being spent entirely in the college, and the greater part of the third year being passed as pupils to a mechanical or civil engineer. At the conclusion of their practical course the students will return to the college to complete their final examination, conducted by examiners appointed independently of the college authorities. Then, on being pronounced qualified for the public service, they will be sent out to India. The Government undertakes to place each student with either a civil or a mechanical engineer for eight months. The limit of age is between seventeen and twenty-one for admission.

Salary of Engineers.—These young men when they enter the service will receive a salary commencing at £420 a year.

Number of Engineers required in India.—The Government of India estimated that to keep their establishment of engineers full, about fifty men per annum should be sent out.

The staff on the Ganges Canal at the present time is very much larger than it was when the canal was in course of construction. The management of the canal, and the distribution of the water, is much more laborious than the mere making of the canal was. Therefore there is no probability that these officers will be cast adrift eventually.

Military engineers are kept up to the extent of seven battalions, or 336 officers. That establishment is kept full, and therefore that number of officers is always available.

Examination by the Chairman: When you state, as an illustration, that you employ these very costly engineers in superintending the working of such a work as the Ganges Canal, is the Ganges Canal a work that ought to require more than one civil engineer to superintend it?—It is generally found, I think, that an engineer can manage properly about thirty miles of canal with all its branches, and that he cannot efficiently manage more.

Do you mean that it is necessary for the superintendence of a canal to have an engineer of this costly character for every thirty miles? —I do not think that he is more costly than any other European would be.

Do not you think that a small piece of canal like that could be worked by a native at a very small salary?—I should say not, certainly.

What engineering is there requiring any skill at all when the canal is constructed, would not a person of the standard of a skilled sapper and miner be quite competent to superintend the canal?—In the first place it must be remembered that these officers combine very considerable fiscal duties with their engineering duties, and they are subject to great temptations. If you go below that class in life in which it is disgraceful to take a bribe, I think you are exposed at once to a great deal of loss, much greater than the salaries you pay.

Are not fiscal duties undertaken by natives constantly?—I do not think that any native has the same responsibility that a canal officer has in the selling of the water, and the management and assessment of it.

Do you contemplate on that principle, that wherever there is a charge of expenditure and income there is to be a skilled engineer, and not a native, entrusted with that?—I do not say necessarily a skilled engineer, but you must have a person of skill on the spot, and it is much cheaper to have the two requirements combined in one person.

COLLEGES IN INDIA.

At Roorkee there are something like 150 students preparing to become native subordinates, the greater part of the staff and the whole arrangements are adapted for these subordinate classes. The upper department is a kind of afterthought imported into the college afterwards. In India, for engineering, Roorkee is the largest, and one at Calcutta, a branch of the presidency or general college. Then there is a civil engineering college at Madras, and another at Poona, but the Roorkee establishment is very much the largest of the whole, it costs about £18,000 a year, and the native students all receive a stipend instead of paying to go there. The education is in Oordu, or Hindoostanee, it is practically open only to the natives of the upper part of India. Most of the educated natives are Bengalees, and a Bengalee is not an active man physically. They are quite intelligent enough, but they do not take kindly to the work of engineering

at present. The Mahrattas have plenty of physique, that is true, but unfortunately the Mahrattas have not the means of getting a high education to start with.

ASSERTIONS.

At Roorkee the Government have offered very high attractions to the natives, which they have not at all responded to I think eight scholarships, including free education, and a considerable stipend, are offered every year to induce natives of India to come forward, but they have not responded to anything like the same extent.

CONTRADICTIONS.

Cross-examination by Mr. Fawcett: We have not made as good an effort as we might have done to find out how much of these public works could be carried out by native engineers?—I do not think that we have. In Madras and Bombay sufficient encouragement has not been given to the natives in regard to engineering. Of late years the number of men who have passed the qualifying examination has been much greater than the number of men who have received appointments.

Therefore, while you were establishing an engineering college in England, there were qualified native engineers to whom no employment was given?—But that statement must be considerably qualified. The fact of a native passing an examination in any form is no test whatever of his qualification as an engineer. That was found at Roorkee and Calcutta, and the outcry was raised by the senior (English) engineers that these men, appointed by a mere academical test, were unfit for practical work These colleges in India were not established primarily to train native engineers, but to train native subordinates, who are taught in the vernacular. I think the native subordinate, as a rule, is quite equal to the European, if not better.

The result of the present plan is, that you admit young men from Cooper's Hill as assistant-engineers at £420 a year, whereas the present scheme only admits a native as an apprentice at £120 a year, and it is left to the indefinite decision of his superior whether he shall receive more?—Yes, but suppose some of the Cooper's Hill students were sent out at the end of the second year in the lower grade, because incompletely qualified according to the higher standard of Cooper's Hill, the natives would not be in a worse position.

But then it must surely be obvious to you, that if you send them out at the end of the second year with £120 a year, they would not go until they were certain that they should be placed in as good a position at the end of the third year as if they had started at Cooper's Hill?—That is the difference, I think very strongly that the natives do not receive their proper share of public employment in India. Practically, India itself is a great school of hydraulic engineering. We teach the principles (in England), but their practical application must come when they enter the service, when one man will go to a railway, and another to a hydraulic work, and so forth. I suppose that there is no country in the world in which the local engineers have had such experience in irrigation works as in India.

EXAMINATION BY SIR D. WEDDERTON.

With reference to the qualifications of natives to act as civil engineers, would you not say that in many Indian buildings, particularly those of the Mussulmans, the very highest engineering skill is displayed ?—I could not say engineering, but architectural skill.

You know the Imaum-bârah at Lucknow ?—Yes.

You know how the roof is constructed ?—Their dome roofs are very clever, no doubt, the great dome of the large mosque at Delhi is a very good specimen. That at Beejapoor is still more remarkable.

The Imaum-bârah is 63 feet span concrete ?—But they appear to have entirely lost the art of building in this way.—(Extracts from evidence given before the P. Select Committee, 1872, by Col Chesney, Principal, and late Accountant-General, P. W D. India.)

DEBATE IN PARLIAMENT, 1872.—GOVERNMENT DEFENCE FOR ESTABLISHING THE COLLEGE IN ENGLAND.

(Speech of the Under-Secretary of State for India)

In 1868, forty appointments were offered (in England) to competitive examination, and how many competed ?—Fifty-nine, of whom only twenty-two passed the minimum qualifying test, and these were appointed [An Hon Member · "What was the pay ?"] £240 a year. In 1869 things were little better, and in 1870 out of seventy competitors for forty appointments only thirteen passed the minimum qualifying test. So they set to work and devised this college. It was said, too, that they were excluding the natives from competing. So far from this being the case, young Englishmen were obliged to pay for being educated for the Public Works Department, while young natives of India were actually paid for allowing themselves to be educated for that service, and the scholarships available for that purpose were not taken up

Mr. Fawcett stated that Parliament had not been consulted, and if such a system were to be continued, what, he asked, was the use of the House going through the farce of discussing Indian affairs ? He hoped the member for Reading would take the sense of the House on this question, if only by way of protest against the system of spending the money of the people of India in England without consulting Parliament, which, in respect to financial matters, was, to a certain extent, regarded by the people of India as their trustee There was no analogy whatever between the Military College at Woolwich and an Engineering College, because the Queen was the only employer of skilled military labour, while the business of the whole world demanded the services of engineers. When the natives of India had got an engineering education they had found it uncommonly difficult to get engineering employment, and that at this time young men who had been educated in native engineering colleges were reduced almost to manual employment.

Mr Dickinson strongly deprecated the tendency to retain the higher branches of the service in the hands of the European, almost to the entire exclusion of the native. The cultivation of native ability was treated as a matter of no importance.

Colonel Syke said: By the present scheme the natives of India would be entirely excluded from profitable employment as engineers in that country—a result that would lead to considerable dissatisfaction. The people of India were not very well content with the existing state of things, and the scheme would increase their grievances. India had produced engineers capable of constructing the most magnificent works in the world long before we had ever had anything to do with the country, and it would be very unfair for us to turn round upon the native engineers and exclude them from employment.

Resolution against Government.—Dr. Ball said, if there were no other person who would insist on a division of the House on the question he would. The House then divided. For the amendment 52, against 46, majority against Government 6. The result was received with loud cheers.—(Extracts from *Times*, 4 March, 1871.)

ROORKEE COLLEGE.

(By Lieut.-Col. J. G. Medley, R.E, Principal)

The Thomason College, Roorkee, has been founded about twenty-five years, and now contains about 250 students. There is an engineer class, consisting of a few artillery and line officers and some thirty civilians, who undergo a two years' training to fit them for the posts of assistant engineers in the P. W Dept.; another class of officers, who stay only seven months, and are trained for the Quartermaster-General's department; a class of soldiers who are trained as overseers, and a large native class, who are educated as sub-overseers, sub-surveyors, estimators, and draughtsmen

Roorkee also possesses a foundry and workshops, belonging to Government, which are interesting as having been the first of the kind erected in India, twenty-four years ago The workmen are all natives, and some of them are remarkably clever and intelligent. They will make anything, from an iron bridge or a steam engine down to a railway key, and they turn out excellent spirit-levels, prismatic compasses, &c. Near Roorkee are also the greatest works of the Ganges Canal.—(Indian Engineering, 1873, p. 41.)

INDIA THE PROPER FIELD FOR TRAINING ENGINEERS.

(By Lieut.-Col. Tyrrell, late Executive Engineer in India)

The establishment of any engineering department should have for its object not merely the development of the resources of India, but it should also equally and primarily aim at the development and advancement of the intellectual and practical knowledge of the natives, and teach them not only to work, but to design Secondly, that any engineering establishment must be the most economical and simple that can be devised, and not made with a view of finding high pay for a number of European officers, but made solely to bring out the resources of India, intellectually and materially, in the quickest, least expensive, and most efficient manner.

India is the proper field for the student of the Indian Public Works. What a study for an engineer is the river system of India—rivers almost dry in the hot weather, and in the rains rising perhaps sixty feet in one night, and pouring forth floods such as are seldom seen in other lands. Engineers for India should be brought up amongst her native scenes, and taught to comprehend her difficulties and her power. Irrigation is the most important, as well as it is generally considered the highest branch of the profession. As in India it is without doubt the most important, the most able and active men would be selected for this work India's sons are quite capable, if only taught and trained, and it is our duty thus to train them. After receiving their training in India, it might be made the reward of scholarship that the first and most successful native scholars should pass two years in Europe for the study of important engineering works, the student in India would lose much by not being conversant with the numerous engineering works of Europe.

DISGRACEFUL IMPOSITION ON INDIA.

The basis of any engineering college for India should be, and must be, that it is perfectly and easily accessible to the native, and no college can be that which is in England. Look at Cooper's Hill, in Surrey, perpetuating a system that has so singularly failed and has cost India so much treasure. Year by year we are hurrying young Englishmen out to learn and practise their brains at the expense of India. Look at any list of P. W. officers, how many native names do you see among them? Yet I say, and no one that knows the natives can deny it, that there are thousands of brains and hands that could do equally well

As a training school for Indian engineers, whether European or native, Cooper's Hill College is simply a disgraceful imposition on India. Intellect, talent, and power will find their vent in India; these elements are daily gaining strength; let us be wise in time, and give them legitimate scope, lest, having sown the wind, we reap the whirlwind.

We have excellent stuff among the natives for engineers, great intelligence, a singular aptitude for figures, the patient eye and hand for drawing. It may be years before any natives are trained with sufficient grasp of knowledge and sufficiently broad views to project or devise any original or extensive plan; say, for the irrigation of an unimproved tract, or other great work, but to carry out the plans of a competent superior there could be no better executive agency. Our engineers, bred and born in England, have had generally little or nothing to do with irrigation. No engineer, it may be honestly said, has had experience of irrigation or canal works on the scale that we require for India. Then we have to train men to comprehend and grasp the immensity and the gigantic proportions of this work. Has not this very want of practical knowledge in the most essential branch of engineering for India been the cause that so little has been done? —(The Future of India, by Lieut.-Col. Tyrrell, 1874.)

ANNUAL LOSS FROM THE NEW ENGINEERING COLLEGE, COOPER'S HILL, SURREY.

CAPITAL OUTLAY.

Purchase of estate with buildings	£58,390
Cost of alterations, furniture, &c.	33,134
Total outlay from Indian revenues .	£91,524

RECEIPTS IN 1872.		EXPENDITURE IN 1872.	
Fees from students . .	£3,980	Professors' salaries . .	£10,296
Sale of farm produce . .	566	Examination expenses .	1,304
		Interest on outlay, at 4 per cent.	3,650
	£4,546		£15,250

Thus the annual loss paid from Indian taxation to train English engineers in England, for service in India, amounts to more than £10,000. It is a disgraceful imposition on India. The best course is to sell off the property, and shut up the college doors.

PLEA FOR ESTABLISHING ENGINEERING COLLEGE IN ENGLAND.

Questions by Mr. Grant Duff, late Under Secretary of State for India, Answered by Gen. Strachey, R.E

I want to ask you, have the natives of India, in your judgment, ever shown any particular genius for engineering as distinguished from architecture?—No, certainly not.

And there is no good reason to suppose that our Public Works Department will ever be very largely or powerfully recruited from the natives, at least not for some time to come; there is nothing as yet to show it?—Well, certainly, there is no reason based upon anything that they have done in the past, I am not going to express an opinion as to what they may be able to do in the future.

Nothing has happened in the past to give one very sanguine hopes? —Nothing at all, certainly, but that there have been very large works executed there is no question at all.—(Evidence before the P. Select Committee, June, 1872.)

"GENIUS FOR ENGINEERING."

Questions of Mr. Fawcett, M.P., answered by Col. W. A. Crommelin, R.E, Inspector General of Military Works.

As far as we know officially, these barracks, which were some of the most expensive in India when they were constructed, were denounced by an official committee appointed by the Government, as being unfit for human occupation?—They at present remain under that stigma.

The executive engineer officer who was in charge of these works was Captain Faber, R.E.?—Yes

Captain Faber was not a young officer?—No, not young in years.

He was an experienced officer ?—He was an inexperienced officer.

How long had he been in the service; more than twenty years, had he not ?—I cannot say.

Who were the two people who were under him ?—I cannot speak from recollection.

They were a Mr. Wilkinson and a Serjeant Herbert, and these barracks were masonry barracks, and it was proved that neither one of the three had the slightest acquaintance with masonry works, this was brought out in the report, was it not ?—It was.

Contractors had nothing to do, and that they were constructed entirely by the Public Works Department ?—Yes.

Questions by Sir D. Wedderburn.

We were informed by General Strachey, that up to 1872—73 we should have expended nine millions in barracks. If we have spent nine millions, and ten millions is the original estimate, may we infer from that that there is only one million more to be expended ?—I arrive nearly at the same result, but in a different way.

Questions by Sir G. Balfour.

You state that accommodation for 15,000 men has been completed, and for 5,000 remains to be completed, at the cost of $1\frac{1}{4}$ million ?—These are rough calculations.

You said also that 20,000 troops now represent the increase of the European force as compared with the force before the Mutiny ?—In round numbers I could not get precise return; but I think that may be accepted practically.

Before the Mutiny we had, therefore, barracks equal to a force of 45,000 ?—No, it was not complete for that number.

Lord Dalhousie states that "within eight years new barracks have been built, or are being built" He also added, "Old barracks have been replaced, or are being replaced, by new buildings ?"—Quite so.

Therefore, in different parts in India, before Lord Dalhousie gave up his administration, we had extensive barracks, of a new description, built for the troops ?—Certainly

These barracks being of a very excellent description, as you have stated, the improved barracks to be completed for the additional force were merely for 15,000 men ? That is all that we have done up to the present time.

The statements which you have made are entirely referring to the barracks for Europeans ?—Entirely.

Were the barracks for natives of a very primitive character ?—They very rarely existed. The natives generally hutted themselves. —(Extracts from evidence taken before the P. Select Committee, February, 1873)

ENGINEERING GENIUS.

Several ranges of barracks on the Government standard plans have been (recently) erected at Allahabad, Saugor, Jullundur, Peshawur, and other stations, but it cannot be said that the results have been

at all commensurate with the large cost incurred. The heat and glare are greatly complained of, and in more than one instance it is believed that a return to the old temporary thatched barracks was urged.

Neither our barracks, churches, nor private houses are as yet satisfactory, and as to their architectural appearance, the less said about that the better. The best of our public buildings, law courts, town halls, &c., are anything but adapted to the climate. Imitations of classical, Italian, and Gothic architecture are plentiful everywhere, but few attempts have been made to adapt any of the features of Oriental architecture to our Western requirements. Yet who can gaze on the beautiful domes and minarets of the Taj Mehal or the Jumma Musjid, or the graceful arches and bold cornices of the Motee Musjid, without admiration and envy? It is much to be desired that the whole subject should be carefully studied. If you cannot be original (and doubtless the genius of originality is given but to few), then study the noble specimens of Eastern architecture that are still left to us, strive to comprehend the meaning and intent with which that style was designed, you may then catch something of the spirit of those great builders, and produce something at least suitable to the climate and the country, and creditable to the taste, which does not form a grotesque excrescence out of harmony with everything around it.—(Indian Engineering, by Col. Medley, R.E.)

HOW MANY ENGLISH OFFICERS CAN DESIGN IRRIGATION WORKS?

Very few of the Bombay Public Works officers have experience in the designing or management of irrigation works. Under these circumstances, the best course would be to strive to extend the provision of irrigation by regarding those places where the engineers are now actually constructing irrigation works as centres from which to advance. In Guzerat, one or two additional special surveying officers could usefully be employed, no works of this sort having hitherto been taken up there.—(Report of Col. Strachey, Inspector-General of Irrigation Works, B.B. 369, 1870, p. 85.)

DEFECT IN DESIGN.

Baree Doab Canal.—The charge for repairs is still very high as compared to the older canals; but the canal bed is known to be in a very unsatisfactory state, owing to its excessive slope, and, until this defect is remedied, the cost of maintenance must continue to be heavy.—(Government Resolution, November, 1868, B.B. 389, p. 185.)

MISTAKES IN DESIGNS OF WORKS.

(By Captain W. Jeffrey, R.E.)

Ganges Canal—The defective irrigation must in a great measure be traced to faults in channels for the distribution of water, and this is most assuredly the case. None perhaps produced more prejudicial results than the defective alignment of the distributing channels.—(Extract from Professional Papers, Indian Engineering, 1867.)

CAREER OF A YOUNG ROYAL ENGINEER.

On landing at Bombay, he will be directed to proceed to Roorkee, where he will have to do duty with the Bengal Sappers and Miners for a year. The idea being that in the interval he will acquire some knowledge of the language and of the customs of the country, generally speaking, before the year is out, the young officer will read in the Gazette of India that his services have been placed at the disposal of the P W. Dept ; and in the next Gazette that he is posted to such or such a province, then a week later, in the local Gazette of that province, he will be posted to a particular circle, and the superintending engineer of that circle will desire him to report himself to some particular executive engineer. The day after his arrival he will find himself employed, either surveying and levelling, or drawing plans and making calculations, or in a tent in the middle of the jungles superintending the building of a bridge. For the next four or five years he will probably be changed about a good deal from one work to another; then he will find himself an executive engineer of the fourth grade, and in charge of a division; while, after running through the four executive grades, another ten years or so may carry him on to the higher grade of a superintending engineer.

As to the importance of the work entrusted to every young engineer, he will find himself almost immediately entrusted with responsibility, and, before long, in charge of work that he could not expect to have confided to him in England until many years of service had rolled over his head.

Not a few men enter the Survey, which is, however, quite a separate department, divided into three branches—the Trigonometrical, Topographical, and Revenue—and the promotion in it proceeds *pari passu* with that of the Public Works Department.—(Col. Medley's Indian Engineering.)

SALARIES PAID TO ENGLISH ENGINEERS IN INDIA.

Rank.		Salaries per annum.
Chief Engineers	First Class	£3,000
,, ,,	Second Class	2,400
,, ,,	Third Class	2,160
Superintending Engineer,	First Class	1,920
,, ,,	Second Class	1,620
,, ,,	Third Class	1,320
Executive Engineers	First Grade	1,140
,, ,,	Second Grade	960
,, ,,	Third Grade	780
,, ,,	Fourth Grade	660
Assistant Engineers	First Grade	540
,, ,,	Second Grade	420
Qualified Students, New C. E. College (England)		420

In India more than nine hundred English engineers are employed. The cost of establishment, P.W.D., amounts to more than a million sterling per annum, which chiefly consist of salaries paid to English

engineers. The average cost of establishment for any given work is 25 per cent. Supposing a work to cost a million, a quarter of a million is expended for designing and superintending the work

PARTIALITY SHOWN TO MILITARY ENGINEERS.

The most that civilian officers can expect is to officiate in these appointments while the military officers are at home, and then go back to the lower grade when they return. The chief engineers' grades are never considered supernumerary at all, though officers in them may be absent several years Thus practically chief engineers make no vacancy till they retire; and other officers only if they are absent a whole year and upwards. Promotion, it will be seen, is thus reduced to its very minimum.

It is a common thing for Royal Engineer officers to get exchanged into the Public Works Department, and, after learning its duties for a few months, to claim a grade corresponding with their seniority of standing in their corps. Thus a military man who has been, say, six months in the department, steps over the heads of civil men who have been at practical engineering in it for perhaps twelve years.

In no country in the world, I believe, except India under English rule, could such anomalies exist —(Extract from a letter to the editor of *Engineering*, 27 October, 1871.)

SIR ARTHUR COTTON'S NOTE ON MISTAKES IN BLUE BOOKS.

Strange mistakes have found their way into the Blue Books. It is necessary to correct some of the items given in the tables in the finance and revenue accounts of India for the year 1871—72. At pages 9 and 110 of this Blue Book (reprinted in this work, p. 289), the capital expended on the Godavery Delta works is stated to be £287,000 up to 1872. Now the actual amount is £600,000. The Cauvery Delta works are stated at £59,000. They have cost about £300,000.

In the Blue Book, "Moral and Material Progress of India, 1872," the area irrigated in the Godavery Delta works is stated at 220,000 acres. The actual area by official returns from the district is 560,000 acres, and there is reason to believe that this is understated.

The Pennair and Cauvery Delta works are stated at 875,000 acres, but the actual area in the Cauvery alone is more than 1,000,000 acres.

The actual returns for the Godavery Delta works are—cost, £600,000; area irrigated, 560,000 acres; water rates, £180,000.

In the Blue Book, financial accounts, 1872, at p. 110, the repairs in the Godavery Delta works are stated at £45. They are about 3 per cent. on capital outlay: or, on £600,000, £18,000.

There is no remodelling of the works going on, but extension.

In the Madras Revenue Returns (p. 185 of this work) the assessment of the Godavery Delta irrigated lands is stated at 2 11 5, and the Kistna at 5 8 8; the water-rate in both is the same. For rice, Rs. 4 and the land-tax, Rs. 2. The area in Godavery is stated at 203,000 acres, and the assessment at Rs. 589,000. The actual area is 560,000 acres, according to other official returns; and the water-rate £180,000; and the total assessment, including the land-tax, about £300,000.

There are locks at intervals on all the great irrigation canals in India; viz., the Baree Doab, the Ganges, the Jumna, the Godavery, the Kistna, the Sone, &c.; and at each there is a fall of six or eight feet, with a water powor of from 100 to 1,000 horse power. In the Ganges Canal there is an enormous power all the year round, except when the canal may be closed for repairs. In most of the other canals the power varies at different times of the year; probably on many locks the water power does not fall below 200 horse power. For driving machinery, the various circumstances and water power of each will have to be examined into particularly.

ARTHUR COTTON

Dorking, 1*st September*, 1874.

HOW PUBLIC WORKS SHOULD BE PROSECUTED IN INDIA.

(By Sir Bartle Frere, Member India Council, London.)

THE PRESENT DEFECTIVE SYSTEM.

We will call the gentleman who first proposes a road, be he collector or commissioner, the satrap of the district He gets hold of an engineer, not without much personal trouble and correspondence, and he tells the engineer that he is to survey a road 200 or 300 miles long, and that he is to send in a plan and an estimate of the cost. The design at last is drawn out, and then commences the agitation to get the plans and estimates approved. It is not one satrap only, but there are a dozen in every province, all knocking at the door, and each urging on the Local or Imperial Government his pet project for immediate execution. When the plans and estimates have been considered by the provincial governor and approved, then comes the difficulty of getting estimates into the budget. The sum to be distributed is limited, applicants numerous; each knows his chance of getting a share depends on the urgency of his application. Sometimes all are cut down by a sudden contraction of the whole sum disposable; sometimes there is a scramble for an unexpected sudden addition. The whole system is as unfavourable as can be to a calm consideration of the great works which the country wants and the best means of supplying them. At last we will suppose the work is fairly "budgeted," and entitled to have a certain sum spent upon it There is a certain sum—a very small proportion probably of what could be profitably spent on the work—set aside to be laid out upon it during the year, and beyond that it is impossible that any energy should push it on faster during the next twelve months. The same process has to be annually repeated. The work drags on in this way till at last it is completed—if completed at all—almost invariably by some other persons than those who originated it and designed it.

The present system is one by which an engineer officer proposes a work, which is aftewards revised by another officer 100 or 200 miles distant, then again by another officer, who is perhaps 400 or 500 miles distant, then again by another officer, who is perhaps 1,000 or 1,100 miles distant, and then in many cases by others who are 7,000 or 8,000 miles distant.

HOW IS CAPITAL TO BE PROVIDED?

This is in fact the question which lies at the root of all our financial difficulties in India. I doubt if any man in his senses, who really knows the extent of this work, would dream of doing all that India requires out of the surplus revenues of India, then you come to borrowing. How would you borrow? A similar question has been fully considered, and very satisfactorily solved in this country. By borrowing under Acts of Parliament, and under conditions to pay a particular sum in excess of the ordinary interest on the capital raised, by which the loan is extinguished in a few years. The system is extensively acted upon, there is no sort of practical objection found to attach to it, either financially or in any other respect The work appears to be economically and promptly done. The work is done with public money, or rather, with money raised on public credit, under the sanction of Parliament, and this is all done under conditions which enable the minister of the day at once to lay his finger upon the person who is responsible for any malversation. I would ask, whether it would be possible to misapply any large sum which had been raised to be expended? That is a state of things with which you have no parallel in India, but is precisely the state of things at which you would wish to arrive there There should be an annual report to Parliament. Short accounts make long friends The sooner you bring men to a strict account of what they have done in a matter of trust the better. Each local government would tell the trustees what security it proposed to give in payment of the loan If it had the authority to pledge any part of the revenues of India it would pledge them. With regard to the very great desirableness of setting aside a fixed part of the land revenue for the improvement of the land—that is a system I have always thought a very excellent one, and one which I trust may some day be carried out.

Conclusion.—So far from dissevering the Government of India from efficient control over the works of India, the system which I have suggested would greatly intensify that power of control. At present the power of control and responsibility are so divided and scattered between the men who designed the work twenty years ago, the men who have been carrying it out and changing it every four or five years since, and the men who have finally come in at the end, that when anything goes wrong you do not know who is to blame. And that is the evil which the Government has to complain of Having been myself a member of that Government of India, I feel assured that it would be much easier to lay your finger upon the criminal and to punish him.

Why should the sum to be borrowed be a large sum? Anything short of a very large sum will be absolutely found useless. Consider that there are in some cases 1,000 miles—there are in many cases 500 miles—through which you may draw a line on the map, inhabited by industrious agriculturists, and men of commerce, and along the whole of that line you will not be able to find a made road. It is utterly impossible to run a canal, or to run a common road,

through an agricultural district, without enabling the Government to double what directly and indirectly it gets, not from indirect sources of revenue, but what is needed can only be done by borrowed capital, that capital can neither be borrowed nor properly administered by the present machinery connected with the Government of India, and it is the bounden duty of Parliament, as the only ultimate referee in this matter, to provide that machinery, which I believe to be both extremely simple and extremely free from any chance that it will add one shilling to the expenses of India.—(Abstract from an Address delivered before the East India Association.)

"A SYSTEM OF PATCHES."

A young officer was some time ago ordered to go and plan immense reservoirs, to contain 1,000,000,000 cubic yards of water or more, perhaps the most critical work an engineer could be called on to plan, as such terrible destruction might follow upon its failure. This officer had never seen a tank. What can stand against such management? What should we think of a man being strongly recommended as a cook who had never seen a saucepan?

Is not this one perfectly true statement sufficient to show the present utterly fallacious state of things? The chief authorities can't move until some subordinate officer whose view is confined to his own district conceives. Are not the chief authorities the proper persons to suggest works, taking a comprehensive view of the wants and circumstances of the whole country? What but a system of patches can be the result of such a system? And this is the actual result in respect of everything except the railways. In the case of them did the Government wait till some subordinate local officer conceived and brought forward a plan for a little patch of railway in his district? There the only rational principle of the chief authority planning a general system of works, and then calling upon subordinates to carry out the details, was acted upon

Could anything be conceived more absurd than the course as the one now usual? It is literally turning the whole matter bottom upwards. The subordinate local officer is to plan the work *ab initio*, for which he must necessarily be incompetent, and the distant superior, unacquainted with the localities and without the necessary experience, is to settle the details. This is what is continually done.

When, after forty years' actual practical experience in irrigation, I reported upon the Province of Orissa, my paper was decided upon by an officer not quite old enough to be my son, and who had never seen an irrigated delta; and the details of every work in Madras are settled by officers who have no knowledge of the localities.—(Extract from *Times*, August, 1874.)—ARTHUR COTTON.

GOVERNMENT NEGLECT IN NOT DEVELOPING COAL MINES IN INDIA.

THE COAL BASINS OF BENGAL.

(By Mr. W. T. Blandford, F.G.S., Deputy Superintendent, Geological Survey, India.)

In India the minerals are the property of the Government, except in Bengal, where the permanent settlement prevails, where they have been allowed to become the property of the landowner.

All the under-named coal-fields are in the valley of the Damuda, along which they form a slightly interrupted belt of coal-bearing rocks, extending for 50 miles, and occupying at least 1,500 square miles of country. Over at least one-half of this area workable coal-seams, of considerable thickness, occur within a distance not exceeding 1,000 feet from the surface.

1. *Rajmahal Hills.*—The extent of the fields it is difficult to define, because the coal-bearing rocks are covered at their edges in many cases by higher beds. In each small basin, one of which occurs in every large valley traversing the hills, are several seams of coal varying in thickness from three to twelve feet, but the quality is not, in most cases, equal to that of the better coal-seams in the Raniganj field.

2. *Raniganj.*—This is at present by far the most important of the Indian coal-fields, nearly the whole of the coal mined in India being obtained from it. The Raniganj field commences at a distance of 120 miles to the north-west of Calcutta, and is about fourteen miles in extreme breadth from east to west, and eighteen from north to south. The seams of coal are numerous, and many of them are of fair quality, sufficiently good at all events for railway purposes, for the East India Railway, and the other railways which start from Calcutta, have, ever since they were opened, been worked with coal supplied from Raniganj. The seams near Raniganj itself, where the workings are more extensive than elsewhere, show little variation, and are of more uniform quality than those in the north and west of the field, where, however, much good coal exists.

3. *Jherria.*—This field commences only ten miles to the west of the Raniganj coal-bearing tract. It is twenty-one miles from east to west, nine miles from north to south, and contains numerous seams of coal, some of them of great thickness. No collieries exist.

4. *Bokaro.*—A long strip of coal-bearing rocks, commencing within a mile of the western end of the Jherria field, and extending forty miles from east to west, with a breadth from north to south never

exceeding seven and a half miles. The coal is, so far as is known, inferior both in quantity and quality to that of Raniganj, but it is not worked.

5. *Ramgarh.*—A small field, thirty square miles in extent, south of the last, and of the same character.

6. *Hoharo, or Kranpura Coal-fields.*—Two basins of coal-bearing rocks, respectively 472 and 72 square miles in extent, lying immediately west of the last-named fields, and due south of the civil station of Hazaribagh They contain apparently a considerable quantity of coal of fair quality.

From the above details it will be evident that in the portion of India to which coal-bearing rocks are restricted there is a practically inexhaustible supply of the mineral.

EXTENT OF BERAR AND CHANDA COAL.

(By Mr. Hughes, Assistant Geological Survey, 1870.)

Area 1,000 *Square Miles.*—The total area of the field exceeds 1,000 square miles, but my season's work does not embrace more than 560.

Berar, 480 *Million Tons.*—The area of the field is 149 square miles. The average thickness of the coal is 40 feet, the total amount of coal, therefore, is 149 28 by 40 by 1,000,000, equal to the entire amount of coal in tons, viz., 4,840,000,000. Dr. Oldham's estimate has reference solely to the amount which may be considered economically accessible (according to present system of working in India).

Chandah.—An estimate of the amount of coal in the Chandah district is necessarily imperfect The outcrop of the seams, east of Chandah, would, if they were not overlapped by the Kamthis, be exposed on the Muhl Road, about half a mile west of the Jarpat Nodi. If this be so, a calculation will show that, at the distance of a mile east of the outcrop, with a dip of fourteen, the depth to which the coal will have sunk will be 1,300 feet; at two miles, 2,700 feet; at three miles, 4,000 feet.

Ghugus.—The Ghugus area is about 2·75 square miles, allowing 40 feet of coal, this gives 110,000,000 tons.

Majri—The boundaries of this area are the Sirnadi, the trunk road between Nagpoor and Chandah, the river Wurdah, and a line about three miles north of Warora, joining Mukta and Chimira. Within these limits the coal probably occupies twenty-two square miles Again, allowing 40 feet, this gives 880,000,000 tons.

Conclusion—From the foregoing facts regarding the coal and iron of the Wurdah field, it will be seen that the "woon" portion of it is specially favoured. A large quantity of iron ores exists, and there is a vast reservoir of coal to utilise it in close proximity. Side by side with the fuel, iron ore extends continuously, or almost continuously, from the Peimgunga to Sirpur, a length of ten miles.

COAL AT PIT'S MOUTH, 8*s.*, COST OF CARTING 69 MILES, £2 10*s.* PER TON.

The present cost of the Mayo Colliery coal delivered at Wurdah, sixty-nine miles from the pit, is about twenty-five rupees per ton.

The cost of the coal at the pit's mouth is now four rupees per ton; the heavy balance, of twenty-one rupees, representing the charge for cart-hire from the pit to Wurdah. Mr. Bernard estimates that when the workings become larger and the plant better, the cost of the coal at the pit's mouth will be considerably reduced.

The coal of the Wurrora field is believed to be considerably superior to that of the Ghugus field (Mayo Colliery).

A pit has been sunk on the spot (within a few yards of the main road from Nagpore to Chanda) where coal was struck by the borer

The chief cause of the heavy cost at the railway station of the coal of the Mayo pit is the long land-carriage which it has to undergo By the discovery of coal at Wurrora, the distance the coal has to be carted has now been reduced by twenty-three miles, or by one-third. There is reason to hope that the new coal will prove superior to that of the Mayo Colliery. The benefit to the cotton trade of an ample supply of cheap coal will be great.

HARRY REVETT, Carnac, Cotton
Camp, Boolundsheer. Commissioner.

NERBUDDA COAL MINES.

The Great Indian Peninsula Railway is supplied from these mines at present with an average of 1,200 tons per month, at 18*s*. per ton. The coaling station is Mulpani. In 1874 a new shaft was sunk on the plains. The result hoped for is to supply all the requirements of the railway The native miners who work inside with the pick are paid by the tram, getting four annas (6*d*.) per tram load. Two men can pick sufficient to load three trams. About 70 day-miners, 250 labourers, and 115 women are employed at the mines.

EXTENT OF COAL IN INDIA.

(By T. W. H. Hughes, C.E., F.G.S., Assoc. Royal School of Mines.)

It will doubtless surprise many to learn that both in the superficial extent of its coal measures and associated rocks, and in the actual amount of its coal, India is surpassed by few countries, and that with respect to the size of some of its seams it stands preeminent. Even that land of monstrosities and natural wonders, the United States of America, can exhibit nothing to compare with the gigantic seams of the Hengir and Damuda coal-fields, some of which are 160, 120, and 100 feet thick These figures of course do not imply that there is this amount of pure coal, the term seam is used in its technical sense, as embracing the whole sum of coal and partings in a given bed. Taking the coal-fields already partially and in whole examined, and allowing for the unsurveyed portions of Central India, Assam, Burmah, and the Tenasserim province, &c., we may safely assume 35,000 square miles as being within the mark. This mileage is made up as follows:—Godavari area (including its affluents), 11,000, Son, 8,000, Sirgujah and Gangpur area, 4,500, Assam, 5,000; Narbada area (including its affluents), 3,500; Damuda, 2,000; Rajmahal area, 300; unsurveyed and uncomputed areas, 2,700; total, 35,000 square miles.

CONSUMPTION OF NATIVE AND ENGLISH COAL PER ANNUM ON INDIAN RAILWAYS.

Railway	Tons	Price.	Cost
NATIVE COAL.			
		£ s d.	£
East India . .	120,578	0 7 6	42,212
East Jublepore . .	8,936	1 7 11	12,472
G I Peninsula . .	8,908	0 16 6	7,350
Eastern Bengal . .	14,812	0 13 7	10,018
Total . .	153,234		£72,052
NATIVE WOOD			
G. I. Peninsula . .	2,192	0 12 11	1,352
Madras . . .	49,942	0 8 2½	20,110
Sinde	41,646	0 13 9½	28,766
Total .	93,780		£50,228
ENGLISH COAL			
G. I. Peninsula . .	50,925	1 19 8¾	101,160
Madras . . .	5,900	1 13 8	9,756
B. and Baroda . .	15,110	1 19 1½	29,564
Scinde . . .	9,008	2 14 9	24,676
Total . .	80,944		£165,136

TOTAL COST OF FUEL ON EACH RAILWAY, INCLUDING PATENT FUEL, ETC.

Miles.	Railways.	Tons.	Price.	Cost	Lbs. *
			£ s. d	£	
1,503	East Indian . .	131,018	0 7 9	51,070	53
1,278	G. I. Peninsula .	81,205	1 16 11	150,024	45
835	Madras . . .	59,897	0 13 10	41,286	77
410	B and Baroda, &c.	19,697	1 19 0	38,445	48
676	Scinde, &c. . .	55,148	0 18 10½	52,058	96
168	Great Southern .	3,666	1 13 8	6,172	31
156	Eastern Bengal .	14,032	—	10,724	60
396	Oude & Rohilkund	5,136	0 12 6	3,206	103
18	Carnatic . .	396	0 14 1	278	62
28	C. & South-Eastern	1,080	—	1,051	70
27	Nulhuttee . .	308	—	329	43
5½	Oomrawattee .	170	1 17 10	321	5
7½	Kamgaun . .	80	1 17 10	151	51
5,511	Total . .	371,833		355,115	

* Fuel consumed per train mile in pounds.

LORD MAYO ON INDIAN COAL.

I rode through a large portion of the Chanda District during the last few days, and all I could say is that though the country is wild, and much of it as yet uncultivated, yet it is proved beyond a doubt that coal, cotton, and iron can be produced in almost any quantity within a very short distance of each other, and I am not sure that nature could have provided any district in the world with three greater elements of prosperity and wealth. I have no doubt that before very long a systematic beginning will be made for bringing to the surface and extracting from the soil such rich treasures —(Extract from a speech by the Viceroy, March, 1870.)

THE NATIVE HEWER IN BENGAL.

The native hewer never gets more coal by the present system than about half a ton per day, and this get is the same in amount whether the seam be 6 feet or 30 feet in thickness. If coal-hewing machines can be worked with economy in English coal mines where a workman can do ten times the work of a native Indian miner, how much more must be the economy of their use in Indian coal-mining?

COAL-CUTTING MACHINERY.

Its advantages are now being recognised by colliery proprietors. It has been proved most satisfactorily that by machinery coal can be cut much cheaper than by hand, as considerably less slack is made whilst being worked by compressed air. The ventilation of a mine is improved by the discharge of the pure air at every stroke of the tool. The principal machine in use is that of Messrs. S. and W. Firth, of Leeds, which is on what is known as the pick principle. By it something like thirty yards of coal can be cut to a depth of about 3 feet 6 inches in an hour.

COAL MINES LIGHTED WITH GAS.

The invention of Messrs. Huntriss and Co. for lighting the bottom of collieries with gas by means of steam jets has been adopted at a great many places in Yorkshire, Staffordshire, Lancashire, and the North of England, having been first tested at Darfield Main. Another invention, patented by Mr. Simpson, one of the proprietors of Lundhill Colliery, and Mr. Hurd, engineer, of Walton, near Wakefield, promises to give a great stimulus to coal cutting machinery. It is a system by which air for supplying machines for cutting coal can be compressed in the workings of a mine either by manual or horse power, so that the great objection to coal-cutters—the heavy outlay for taking the air from the surface to any part of a pit—will be done away with.

GOVERNMENT WAYS OF MINING COAL IN INDIA.

The first outcrops were noticed on the banks of the Wurdah, which at its nearest point is some five miles from Chanda, and a pit was dug at a place called Gogoos, some twelve miles from Chanda,

under the superintendence of a Scotch miner, who had been found in the ranks of the 91st Highland Light Infantry. The depth of the seam was here ascertained to be about 20 feet. Major Lucie Smith's apparatus was so imperfect that he was unable to make exhaustive researches, but with the imperfect hand-borer at his disposal he succeeded in striking what appeared to be coal in the civil station at Chanda at a depth of about 100 feet below the surface.

The town of Chanda is not very far from the head of the Godavery Navigation Works, and already attempts are being made to draw a supply of the fine cotton produced in the Wurdah valley down to the east coast by means of the Godavery route. With the navigation works complete and a branch railway running through the country and connecting the river with the Great Indian Peninsula Railway, the coal, the iron, the cotton, the rice, the oil-seeds, and even the magnificent building-stones of this part of India would find easy access to any markets of India where a demand had grown up for them.—(Extracts from Mr. Morris's Administration Report, 1869)

ONLY SIXTEEN OFFICERS EMPLOYED IN THE GEOLOGICAL SURVEY IN ALL INDIA.

Till 1856-57 there was hardly any systematic survey in operation. There was a superintendent, who had a salary of £1,300, with some assistants on small pay, and he was principally engaged, not so much in a regular geological examination of India as in isolated inquiries in connection with the coal fields. In 1856 the superintendent brought the whole subject before the Government, and it was determined to organize the department, improving the pay, so as to secure the permanent employment of competent persons, who would be numerous enough to carry on a systematic survey of the country.

At the present time there are three first-class surveyors, whose average salary is £1,095, four second-class assistants, on a salary of £756; and eight third-class assistants, on a salary of £542 Then there is a mining geologist, with a salary of £715.—(Evidence of Mr. Harrison, April, 1872.)

PETROLEUM IN INDIA.

Petroleum springs abound throughout the valleys of the Bramapootra, Irrawaddy, and the adjacent countries, but no attempt has yet been made to work them

It is said that in the petroleum wells of Burmah, even at the depths at which the shafts are at present sunk, the yield covers the working expenses; but the native workmen accustomed to those operations declare that no true spring has yet been struck, and that the oil at present obtained is only that which has trickled in from cracks of the rocks through which the boring passed. When "ile" is really "struck," they say that it swells up with a simmering sound: and that it will be struck if the shaft is only carried on to thrice the present depth they do not doubt.—(*Indian Statesman*, 1872.)

IRON ORES AND IRON INDUSTRY IN INDIA.

EXTENT OF IRON ORES: OFFICIAL ACCOUNT.

IRON-PRODUCING minerals are widely scattered over India, and consist, 1st, of magnetic and specular iron ores and red hematite, in beds and veins, 2nd, of clay iron ores from the coal-bearing strata; and 3rd, of surface deposits derived from the waste of metamorphic and sedimentary strata, and from laterite.

Some of the most remarkable deposits of magnetic iron ores are in the Salem district of the Madras Presidency The ores occur in immense beds, 50 to 100 feet thick, the outcrop of which may be traced for miles On one hill, six miles from Salem, there are five bands of magnetic iron from 20 to 50 feet thick. At Lohára, in the Chanda district of the Central Provinces, there is a hill two miles long and half a mile broad, the surface of which is covered with masses of almost pure iron ore. In Bandalkhand and in the Narbada valley there are large quantities of hematite ores, the supply in many cases being practically inexhaustible. The clay iron ores in the Raniganj and other Damuda coal fields yield 39 per cent. of iron. The Kamoun iron ores form an argillaceous band, containing large quantities of red hematite, the ore bed being 10 to 20 feet thick. The surface deposits supply the greater proportion of ores used by native smelters, but much labour is necessary in the collection.

Iron has been manufactured in India from time immemorial, and weapons of that metal are even found in the ancient cromlechs and kistvaens, but there never were any large works. The production of iron is the work of poor people of very low caste scattered over the country. They have small clay furnaces, with charcoal for fuel, and the blast caused by foot or hand bellows The smelting goes on for eight or ten hours, at the end of which time from 10 to 20 pounds weight of iron is found at the bottom of the furnace, and is purified by re-heating and hammering.

NOTE ON CHANDA IRON ORES.

(By Mr. Fryer, mining geologist, Government of India.)

The village of Goonjwai is 50 miles E N E. from Chanda. The ore is highly magnetic, and is equal in quality to the rich magnetites of Norway and Sweden

Lohara mines are fifty miles north-east of Chanda. Here, as at Goonjwai, there is a hill of magnetite. Making my way through

jungle, I ascended the hill a distance of about 100 yards, and could find no other stone than pieces of rich magnetite · the expression of the place appeared to me to excel that of Goonjwai, as regards the immense quantity of ore easily obtainable.

Dewulgaon is 68 miles E N E. of Chanda, and is on the east side of the Wyngunga River. Here is a large lode of magnetite clearly traceable for at least 120 yards. The cardinal lode filled up with massive ore is about 10 feet wide, but from this there are many branches, and small pieces of ore are scattered over the country. It is from these scattered fragments mainly that the supply of ore for the native smelting work is obtained.

From the Mayo colliery to Goonjwai or to Lohara is sixty-five miles. The cost of the ore at Mayo colliery would be about 14*s*. per ton

CHANDA IRON EQUAL TO SWEDISH.

(Analysis by Dr David Forbes.)

	Lohara	Dewulgaon.	Goonjwai.
Iron, metallic . . .	69 208	70·006	70 134
Oxygen, in combination	29 376	28 670	28 739
Sesquioxide of manganese	0·090	0·084	0 108
Silica . . .	0 823	0·813	0 545
Alumina . . .	0 432	0·387	0 396
Lime	0 54	0·026	0 055
Magnesia . .	trace	trace	trace
Sulphur	0·012	0 013	0 020
Phosphorus . . .	0 005	0 001	0 003
Total . .	100 000	100 000	100 000

A glance at the results of the chemical examination of these ores will show that they are not only extremely rich in iron, but also that the amount of the deleterious ingredients, sulphur and phosphorus, contained in them, is the minimum known in even the best iron ores of Sweden and Russia

In conclusion, I would only express my opinion that these ores, if smelted with either charcoal or coal of good quality, are extremely well adapted for the production of first-class iron, whether in pig or bar, or intended for conversion to steel.

(Report by Dr. Oldham, Superintendent Geological Department.)

There are two well-marked localities for iron on the Berar side of the Wurdah, in immediate contiguity to the coal One at Yenak yields ore, containing by assay 68·5 per cent of iron, and near Mulargao Hill there are veins of fine brown hematite, yielding on the average of four assays some 56 per cent. of iron. That these ores have been in former times largely used is proved by the abundance of slag, much of which itself yields more than 30 per cent of iron.

The great source from which the native smelters in that part of the country draw their supplies of ore is the enormous deposits of specular iron, which forms almost the entire hill of Lohara, in the north-east of Chanda. This is nearly one mass of ore, yielding about 70 per cent. of iron, extending for about two miles in length.

CAUSE OF FAILURE, KUMAON IRON COMPANY.

Notwithstanding the many and great difficulties inherent in the starting of all new undertakings—to establish a working company was so far successful that furnaces were erected, and nearly 1,000 tons of cast iron of excellent quality were produced. There is little doubt that, had there been the means of sending this to market by rail or canal, the active vitality of the company would have been assured. This element of success, however, was unfortunately wanting, and for want of any immediate prospect of a remedy, the works were closed. To this cause alone, not to poverty of raw material, the disastrous issue of the attempt to utilise the iron ores of Kumaon on a large scale was due. One great drawback also that manufacturing industry in India has had to contend against has been the absence of sustained effort.—(*Pioneer.*)

GOVERNMENT WAYS OF DEVELOPING IRON INDUSTRY.

The enterprise of Government in the Narbada valley promised well. Works were erected at Burwai, on the Narbada, under the auspices of Colonel Keatinge Mr. Mitander, a very able Swedish metallurgist, took charge of the works, and, after all difficulties were overcome, the works were ready for the production of iron. Suddenly, in 1864, the Government, after spending £75,000 on these preliminary expenses, dismissed Mr Mitander, closed the works, and offered them for sale, without success. They have now, with the ground on which they stand, been made over to Holkar Iron ore and limestone abounded in the neighbourhood; large forests, furnishing supplies of charcoal, extended for many miles to the east and north-east; and Mr. Mitander was an excellent manager as well as a scientific metallurgist. No record has even been preserved of the experiments and plans of Mr. Mitander for burning and storing charcoal, and for other processes, which would have been useful hereafter. The Government are now anxious to foster the iron manufacturing industry of India. In 1872 Mr. Bauerman was sent out to report on the subject, and the increasing price of iron in England is most favourable to the prospect of the manufacture proving profitable in India. The use of Indian coal for smelting iron has never yet been tried.—(B. B, M. and M., Progress of India, 1872, p. 90)

IRON-WORKING IN ANCIENT INDIA.

Within the ancient mosque of the Kutub, situate near Delhi, exists a wrought-iron pillar. It is as large as the screw-shaft of one of our first-class steamships, and a forging of the same size would be deemed a piece of first-class work for any one of our great steam-hammer forges in Europe, and yet it is more than a thousand years old, and may be as much as fifteen hundred. Its form is that of a conic frustrum, giving it a very slight swell towards its mid-height. The capital consists of an elaborate Indian design, the whole of which good observers deem to have been carved by the chisel out of the solid iron. The shaft, too, near the present ground level is beautifully smooth and true, and presents the character of having been swaged,

or, if not, sledge-planished to its finished form. The lower part, for 3 or 4 feet, above the present ground and below it, is rough and but carelessly rounded; there appears to be some rather large cavities in this part of the shaft. This pillar has been known to Europeans for many years

The following facts are recorded by Mr. James Fergusson, in his "Illustrations of Ancient Architecture in Hindoostan." In the Temple of Kanaruc, or Black Pagoda, in the Madras Presidency, the walls of the porch (which is about 60 feet square inside) are about 10 feet in thickness, and the depth of the doorways is, consequently, 20 feet, and their lintels are supported by large iron beams of about 1 foot section, laid across from side to side At about half the height, where its dimensions narrow to about 20 feet, a false roof has been thrown across, the remains of which now lie heaped up as they fell on the floor of the apartment. Among them may still be remarked several beams of wrought iron, about 21 feet in length, and 8 inches section, and a great many blocks of stone, 15 and 16 feet long

Here then we have the fact that at Delhi, in the north, at Madras, in the far south of India, massive forgings exist. With such an interval in time as 900 or 1,000 years, and such a diffusion in space as from north to south of India, it seems impossible not to conclude that the evidence of these monuments attests the existence in India for that long period of a great iron manufacture, well established, and with a relative cheapness and certainty of product that admitted of the use of iron as a material for public monuments, and as a building material in sacred edifices.—(*Engineer*, 1871.)

IRON-WORKING IN MODERN INDIA.

(By Lieut.-Col. Tyrrell)

The resources of India as regards iron works should be at once developed You have now coal. In Bengal (the only province where the mines do not belong to Government) alone there are forty-four coal mines at work, and of these there are nineteen each turning out more than 10,000 tons a year, and every year the quantity is increased. The locomotives of all the railways that run to Calcutta, and also the steamers on the Ganges, &c, burn Indian coal. The first desideratum in establishing an iron manufactory is the proximity of the iron and coal. Porto Novo, south of Madras, failed chiefly on this account. It was far from its sources of supply of iron ore, and also of fuel, and that fuel was ill adapted for the reduction of iron ore in large quantities. The only thing that could have saved the Porto Novo works would have been the working of the coal at Mergui, across the Bay of Bengal, and the use of three or four screw colliers to keep up a constant supply. The exposed character of the Porto Novo roadstead was against it. The means of carriage from the banks of the Cauvery for its raw materials were most inefficient. Mr. Norfor, manager of the Porto Novo Iron Works of the Indian Iron Company, in September, 1851, writes, "The reason that this canal does not come into more general use is because no dependence can be placed on it."

The primary object would be, after the production of iron from the

ore, to manufacture it into its most useful forms. The great drawback that always struck me was the difficulty there would be to obtain a constant supply of puddlers. This is now done away with by Bessemer's process. This process especially recommends itself for development in India. Iron castings, rolled girders for bridges, iron piles, screws for screw piles—most useful for bridges over sandy rivers, steam engines, agricultural implements, sectional boilers of the most approved type, machine tools, cotton gins, oil presses, sugar mills, &c, should be made The establishment by Government, of manufactories on a scale commensurate with the wants of this country, I consider the most important step towards the formation of a proper system of reproductive public works. Whether such works would remain in the hands of Government or not would not matter Such works would always be a nursery available for mechanical engineers, and in their proper place for the instruction of the natives of India. It is not only the duty of instructing the natives of India that points out the desirableness of establishing iron works, but also the remarkably good quality of its iron ores. Nor need I more than point out the immense saving in cost price, and also in freight on iron. For two bridges in India, over the Chenab and at Agra, we expend £80,000 cost price in England for that which could be better made and cheaper by at least one-third in India, and we send metal from England to a land teeming with iron ore in its richest forms. Should this be?

Late inventions and late discoveries have entirely cleared the road for us The discovery of coal in large quantities and the invention of Bessemer's process have removed all difficulties. It is time, full time, that our rulers were alive to the great importance of the establishment of iron works in India. On such works must greatly depend the rapidity or otherwise of the advancement of India.

COST OF MAKING PIG-IRON IN INDIA.

	Per Ton. *Rs*	*a*	*p.*
Ore, $3\frac{1}{2}$ tons, at R. 1—say	3	8	0
Kunkur, $3\frac{1}{2}$ tons, at Rs. 2	7	0	0
Coal (large), $3\frac{1}{2}$ tons, at Rs. 3	10	8	0
Coal (small)	0	8	0
Wages	2	8	0
	Rs. 24	0	0

I think there can be but little doubt that, if there is demand enough in India markets, iron may be manufactured in this country. and sold at a much cheaper rate than imported English iron can be bought for. —(Extract from Report on Iron Smelting, by Mr. F. W. H. Hughes, Geological Survey of India.)

MECHANICAL PUDDLING.

At no previous period in the history of iron-making could the substitution of mechanical puddling for the ancient system of hand

labour have assumed such important proportions as at the time in which we live. A legitimate outcome of a positive want, the mechanical puddling furnace was introduced at first in the United States, where the high price of hand labour naturally afforded a powerful stimulus to the ingenuity of inventors The reputation of the new mechanical puddling furnace was not long in attracting attention in England. The Iron and Steel Institute not only sent men, but iron, from different localities from England, to American order, to test thoroughly the applicability of the new furnace to the various qualities of iron produced in this country. Many trials were made, and the result of these acted so favourably upon the Commission as to induce the introduction of the Danks furnace into this country on a large scale No less than forty furnaces were constructed on the new system, which has, in spite of occasional shortcomings, given very general satisfaction. Ultimate abolition of the severe labour of hand puddling may therefore be regarded from every point of view as a step in the right direction —(*Iron*, May, 1874)

CRAMPTON'S PUDDLING FURNACE.

Whatever may have been the financial results attendant upon the application of the Danks process in this country—and regarding these results contradictory evidence appears to be forthcoming—it is certain that Mr. Danks and others have proved that the rotary furnace is capable of turning out a superior product, and that, in fact, it is possible in such a furnace to deal with large masses, and still to perform the pudding better than it can be performed by hand, even when dealing with much smaller quantities.

Mr. Crampton's rotary furnace consists of but a single chamber lined with oxide of iron, this chamber containing the iron to be treated, and forming a gas-producing chamber, a combustion chamber, and a working chamber, the combustion of the fuel being commenced and ended in it As now constructed the puddling furnace consists of a wrought-iron casing 6 feet 8 inches in diameter outside, and about 6 feet 9 inches long, this casing being made double, so that a water space is formed both at the sides and ends. The water casing is one of the chief features, and a most important feature it is.

The results obtained with Mr. Crampton's furnace at Woolwich Arsenal have been most satisfactory both as regards quality and economy of production In the course of an eight days' trial conducted in the prefence of Mr. Briggs, of the Carlton Iron Works, and Mr. Kirk, the average quantity of metal charged was 6 cwt. 3 qrs , and the average time occupied per charge (including fettling) was 1 hour 31 minutes only. The mean increase in the charges when withdrawn was 14·5 per cent., and the quantity of fuel consumed was 11 5 cwt. per ton of iron.

At the last meeting of the Iron and Steel Institute, held in London, Mr Crampton exhibited some admirable samples of iron produced in his furnace. It is owing to the accuracy with which the coal and air and fuel supplies can be adjusted to each other, that has enabled Mr. Crampton to attain such extraordinarily high temperatures while using cold air as the supporter of combustion.

At the Carlton Iron Works, near Stockton, Mr Briggs is now altering eight Danks furnaces to Mr. Crampton's plans, while he is also putting up four new Crampton furnaces, these being arranged so as to form half of a group of eight. At the Newport Works, Middlesbrough, Messrs. Fox, Head, and Co. are also putting down four new Crampton furnaces, forming a half-group. Under these circumstances it will not be very long before data are available respecting the working of the system on an extensive scale; but, after the thorough trial it has had at Woolwich, there need, we think, be little doubt about the results.—(*Engineering*, July, 1874)

PICKLES'S PUDDLING MACHINE.

It is the invention of Mr. Joseph Pickles, foreman millwright at the Kirkstall Forge, Yorkshire. The principle involved is very similar to one often tried, the ordinary rabble being retained. Mr. Pickles takes a framework of iron, and in suitable bearings he mounts a beam, which is caused to oscillate on its centre by means of a crank or eccentric, motion being transmitted by means of a connecting rod. By the combined vertical reciprocating and lateral radial motion of the bell-crank levers the rabbles are traversed in all parts of the iron in the furnace, thereby thoroughly mixing it A small steam engine is mounted on the top of the furnace, and drives the whole of the mechanism. A new furnace has been built at Kirkstall for the purpose of testing this machine, and in the trials which have so far been made of it it has performed admirably. This is a piece of machinery which, when constantly at work, will excite the deepest interest among the ironmasters generally.—(*Engineer*, May 22, 1874)

PICKING INDIA'S POCKET.

(By Lieut.-Col. Tyrrell.)

Is it not a reproach to England that, with the very best coal and iron teeming in India, above £30,000,000 has been expended in England on iron for Indian railways, and that the cost of inland carriage was so great, that iron cost cent. per cent. when landed on the ground, that is, indeed, developing the resources of a country with a vengeance, or picking a country's pocket.

Let us put away the temptation of enriching England by spending £30,000,000 in buying her iron. Let us cease to force upon the country crowds of highly paid European engineers, where native engineers might be earning an honest livelihood in developing the resources of their native land. Government, I am afraid, is somewhat like Professor Holloway. it has but one panacea for all ills—railways! and only looks to one interest, the interest of the shop.

We have worked twenty years for our own profit, let us now give the natives a turn, and we shall find that their profit is also ours. Hitherto the advancement of India does not seem to have been our object so much as our own aggrandisement. We have to provide in India workshops, various manufactories, steamers, &c. There should not be the slightest difficulty in procuring coal for all purposes, if Government would use half the zeal it has in burdening India with

railways. I repeat, we have given no thought to the natives in conjunction with their country! It suited England; it suited English engineers; it suited English merchants; it suited the English people to pour her sons into India on high pay, to saddle her with £93,000,000 for railways, while her people die, calling for water.

No standing army, no railways, will save us, unless we possess the affection and confidence of the people of India. That confidence you cannot gain by expending the wealth of their country, by English ministers, for European purposes, nor allowing their resources to lie idle, while you use your own.—("The Future of India," by Lieut.-Col. Tyrrell.)

ROORKEE FOUNDRY AND WORKSHOPS.

The works were first erected in 1843, in connection with works on the Ganges Canal. In 1852 the works were separated

Financial Result.—From 1864 to the present time the concern has been very remunerative to the State; the value of work turned out, and the profit on it, has steadily increased, while the price of the articles manufactured has decreased. The following statement shows the capital outlay, the value of work executed, nett profit and percentage of profit on capital:—

Year.	Capital.	Value of Work done	Nett Profit.	Profit on Capital
	£	£	£	
1865	108,284	33,528	6,316	5 per cent.
1866	97,308	28,052	2,927	3 "
1867	95,354	32,881	6,619	6 "
1868	110,837	38,244	10,017	9 "
1869	117,841	47,604	12,890	11 "

The Workshops contain a turning-shop, worked by a 20 h.p. engine, a foundry with a 12 h.p. engine, a smith's shop with two steam-hammers, a fitting and boiler-making shop, with a steam rivetter, a pattern-shop, saw-mills driven by a 10 h p. engine, a mathematical-instrument shop, where surveying instruments are made and repaired.

Amongst the works executed are steam engines of all kinds, from locomotives to stationary, all kinds of bridge and girder work, pumps, printing-presses, hydraulic presses, machinery, such as planing, slotting, and drilling, lathes of all kinds, &c The general average of the amount of work done may be taken at two-thirds Government and one-third private

The Benefit to the Country in training workmen and introducing a higher style of work for these workshops has been very great. The average number employed are 419 artisans and 651 labourers. The enginemen and stokers are all natives. With the exception of the turning-shop, all the foremen are natives.—(Professional Papers, I. Engineering, August, 1862.)

NATIVE MECHANICS.

The employment of natives and Eurasians as mechanics is every year carried out to a greater extent. (?) They are trained as fitters, erectors, boiler smiths, &c., and also as drivers On the Great Indian Peninsula Railway the Parsee drivers are pronounced to be as good as Europeans.—(Railway Report, 1873, p. 8.)

MINERAL RESOURCES OF INDIA.

(By Mr. W. T. Blanford, F.G.S., Deputy Superintendent, Geological Survey.)

Copper ore appears to exist near Chaibassa, in Singhbhum, a country lying west of Midnapur, in Bengal. An extraordinary series of deposits, partly in irregular lodes, extends across the country for at least eighty miles Copper has been found and mined in several places. At present there are mines in various parts of the Himalayas, especially in Kumaon, Gurhwal, Nepal, and Sikkim These are all worked by natives on a very small scale, and the produce is inconsiderable. At present I know of no mines which are still regularly carried on, except those near Jaipur, in Rajputana, of which an excellent description was given by Col. Brooke in the *Journal of the Asiatic Society of Bengal*, for 1864 , out-turn from these is far from large

Rich tin deposits are believed to exist in the Tenasserim provinces and Martaban. Though these Tenasserim tin ores have long been known, the excessive wildness of the country, covered with forest of the densest description, the extreme paucity of the population, and the total absence of roads or any means of carriage, have hitherto prevented all attempts at working.

I cannot but think that its iron ores will prove the most valuable mines in the future. Iron-producing minerals of India are widely scattered.

ESTIMATE OF A COLLIERY PLANT

TO RAISE 300 TONS OF COAL DAILY.

(*From a depth of* 650 *feet.*)	£
1 boring machine, complete, with boiler and all accessories .	1,025
1 pump for forcing water, complete with boiler, &c. . .	1,600
1 rock-crushing machine, complete	300
1 coal-cutting machine, with cutters, complete . . .	450
1 pair H winding-engines; 24" cylinder winding-drum, guide ropes, 2 winding ropes, each 246 yards, 3 safety cages, signal apparatus, 100 Davy's lamps, with battery, &c; rails for tramway; iron tubs on wheels; steel boilers, all mining tools	5,550
	£8,925

To work the mine, a competent mining engineer would be required, salary about £600 per year; 2 assistants, £300 each; 5 sub-assistants, salary £200 each per year.

ESTIMATE FOR BESSEMER MACHINERY

FOR CONVERTING IRON INTO STEEL.

A pair of Bessemer converters, with tipping-gear, central casting-crane, on hydraulic system, with movable ram, for carrying casting-ladle; set of valves for regulating admission of air into the central crane; ingot-crane, with fittings for lifting ingots out of the casting-pit; hydraulic pump for working crane; blowing engines, steel boiler of suitable dimension, all complete with pipes, fittings, &c.

	£
Cost of a pair of $1\frac{1}{2}$ tons converter . . .	3,190
,, 2 ,, . . .	4,675
,, 3 ,, . . .	7,150
,, 4 ,, . . .	9,240
,, 5 ,, . . .	11,000

The iron running from the blast furnaces is taken at once to the converters and turned out in the shape of Bessemer steel ingots. At the meeting of the Iron and Steel Institute, September, 1874, one member stated that in making steel with one uniform quality of iron, in three years, not one ton out of every thousand was doubtful.

Mr. Bessemer's first experiments were with Indian ores, which he found from the comparative absence of phosphorus and sulphur, well adapted for his patent process. He is surprised no advantage has yet been taken in India of his patent process.

ESTIMATE, DANKE'S PUDDLING FURNACE.

	£
6 Danke's patent rotary puddling furnaces, with engines, complete	3,600
1 squeezer, with engine, complete	2,000
7 crane ladles, complete	1,000
Boilers, sundries, &c	3,000
	£9,600

THE MATERIAL PROGRESS OF INDIA.

IMPORTANCE OF MANUFACTURES.

INDIA is exceedingly poor, so much so that a rise of 2 farthings per pound in the staple food brings starvation to the door of millions. Even in the fertile and densely populated part of Bengal, in 1874, a failure of one or two harvests, from want of rain at the time when it was wanted, caused a famine. The Government for the first time in the history of India recognised its duty of saving the poorer people from dying from starvation, and expended from State revenues no less a sum than $6\frac{1}{2}$ millions sterling, chiefly in feeding the people. The generous people in England and India also contributed towards the charitable relief. Such is the extreme poverty of the people; the bulk of the people live on one industry—agriculture—only.

One remedy to drive away the poverty from the land is to improve agriculture, and to introduce various manufacturing industries, which may be reasonably expected to take root in the soil. In India this is the duty of the State, and it has been recognised. For example, tea was first introduced in India by the Government, and when the cultivation succeeded the Government tea estates were sold off. The tea industry fell then into private hands, and now it is chiefly carried on by Europeans The export of tea from India in 1872 was more than 17 million pounds, and is increasing yearly by more than a million pounds. The Government also has introduced in India the cultivation of plants which yield quinine; and it seems in a few years it will entirely pass also into private hands. In India, from the peculiar circumstances of the country, the Government must be the pioneer in agriculture as well as manufactures. The outlay and the risk involved in introducing new industries and establishing works of a character which never existed before in the country are so great that it prevents many from going into it. Besides, to leave to the mere chance of any enterprising person the introduction of new industries, is practically to retard the material progress

of the country indefinitely. As a proof, the Bombay Cotton Mills and Calcutta Jute Mills may be pointed out, which were only very recently planted on India's soil, not by the natives, but by enterprising Europeans. There is no doubt, if Government had done its duty in this respect years ago, we should have seen this day in India, five hundred instead of fifty textile factories, and a corresponding increase of wealth in the country, and also increase in Government revenue. Without any hesitation, for India, we positively assert it is the duty of the Government to step in first and expend the revenues of the country for the benefit of the people, from year to year, judiciously and systematically, in laying the foundation of new industries in India, till it takes a firm root in the soil, or till the causes of failure, after repeated experiments, are exactly ascertained, and placed beyond all doubt. The Government must act, not in an intermittent fashion, but take in hand the work of improving agriculture, and introducing new manufactures systematically, with a firm determination to persevere, and surmount all the difficulties and failures, till success is achieved Look how the manufacture of sugar from the beets was first created in France by State aid, after repeated failures, and now almost every country in Europe shares the advantage of this increasing industry. Sugar is made from beets every year to the extent of more than a million tons, while before the year 1800 not one pound was manufactured in all Europe. In Russia it is considered politic by the State to pay a bounty of £4 per ton on all rails made in the country, to give encouragement to her iron industry.

Look at America at the present hour, how she fosters her manufactures, and to what lengths it goes for that purpose—25 and 30 per cent. protective duties! Look at the English colonies, governed by Englishmen—what do they do? To encourage industry in the colony itself they levy a *protective* duty on Manchester piece goods and other English manufactures imported into the colony. They do this for the natural reason, that they take more interest in that land and in the people, where they have made up their minds to spend their lives. They wish the new country where they have settled to prosper, and they find in new colonies for new industries a protective duty is for a time necessary, which it is not in old England, where every branch of industry is fully developed, and a very keen competition exists. The Englishman, who leaves England

for good, feels that if he paid a little more in price for his clothing or his sugar made in the colony he has the great satisfaction, that the community in which he lives shares that benefit mutually, and not people living thousands of miles from the colony.

Just as a child must be nursed and brought up till it can take care of itself, so a new industry ought to be nursed by State aid; more so in India than anywhere else, because the country is exceedingly poor, the people without education living on agriculture only. It is the bounden duty of the State in India to act as a pioneer and to foster arts and manufactures. It has recognised that duty, but not acted to its spirit to any great extent. India is not governed by Indians, but by English statesmen in Westminster and Calcutta, up to this time they have yielded to every outside pressure, and governed India less for the comfort of its 200 millions of people and more in the interests of England. The Government has done something for improving agriculture, but nothing at all has ever been done to introduce manufactures in India, as they believe it will be prejudicial to English interests. In India the Government claims to be the landlord of all the soil, and all the minerals, and all ores beneath the soil, except in permanently settled districts. Though nature has bestowed her gifts of coal and iron in India, the Government has hardly done anything to develop the coal and iron industry. Instead of doing that duty and providing the cheapest means of transit in India, it has, for the benefit of English manufacturers, sent thousands of ships, laden with English coal and iron materials to India. At the cost of India the Government has published eighteen volumes, folio size, with 700 samples of the textile fabrics of India, and presented them to Manchester and other manufacturing towns in Great Britain, so that they may imitate the native hand-made fabrics, and by their machine-made goods annihilate the native manufactures. In fact the Government has given no encouragement to manufactures in India.

In the following pages, we shall try to give some useful information, which may help practically to introduce arts and manufactures in India. The estimates of machinery must be considered approximate. It must be remembered, prices will vary more or less every year according to prices of raw materials, wages, supply and demand. A good idea of the

total cost of any works in India, ready for operation, will be obtained by adding, for freight, 20 per cent., for buildings, &c., about 75 per cent. to the cost of machinery.

We believe England, with its accumulated wealth, with its coal and iron industries fully developed, with energy possessed by few nations, will always keep ahead in manufactures, though it is certain other nations will compete with her. The world's civilisation and demands are increasing, and will increase every year; and the trade of Great Britain will increase, as it has done during the past years, notwithstanding the competition of other countries. Let us wish all nations to prosper and glory in peace, goodwill, and good deeds.

COTTON SPINNING AND WEAVING FACTORIES IN INDIA.

THERE is no country in the world where the population exceeds in number that of India or China. The natives are almost entirely clothed in cotton, and the clothing consists generally of coarse fabrics. The quantity consumed per annum has been estimated from 5 to 20 pounds per head of population. Now, taking only India, with a population of 200 millions, and an average consumption per head of population no more than 3 pounds, the annual consumption would amount to 600 million pounds, quite irrespective of China and other parts of Asia. To supply this very extensive demand of cotton goods for the millions offers a field of vast industrial enterprise, in a country where the raw material is produced, and where labour is cheaper than in Europe. No other branch of industry offers so much scope for investment of capital as cotton, jute, and silk manufactures.

The Anglo-Indian Manufacturing Company, started by Lancashire cotton spinners, for the purposes of erecting cotton factories in India, point out the advantages of manufacturing cotton in India, as follows:—

The saving in cost of transport of cotton from India to England, and all the charges, amounting to 15 per cent. The saving in carriage, &c., of sending to India from England the manufactured article, about 10 per cent. on cost of Manchester goods, viz.:—

1¼*d.* per pound on 30's and 40's yarn			
8*d*	per piece on	39-inch 6 lbs.	shirtings.
8½*d.*	,,	39-inch 7 lbs.	,,
9½*d.*	,,	39-inch 8¼ lbs.	,,
9½*d.*	,,	44-inch 8 lbs.	,,
10½*d.*	,,	44-inch 9 lbs.	,,

The saving of interest on cost of cotton from the time it is bought in India till it is returned in the shape of yarn or cloth from England, amounting to about 5 per cent.

It is clear, therefore, that cotton goods manufactured and consumed in India have an advantage of about 30 per cent. in their favour, in escaping the costs incidental to English-made fabrics intended for exportation to India, besides the important additional advantage of much cheaper and more abundant labour in India. Many years may elapse before the import duty of 5 per cent. on English cotton goods and $3\frac{1}{2}$ per cent. on English cotton yarns is removed; the repeal, however, of this duty will have no appreciable effect on the permanency and progress of cotton-mills in India, where the advantages for manufacturing, in the centre of production and illimitable consumption, are indisputably so great.

The average wages paid in Bombay factories are *9d.* per day to men, and *6d.* per day to women.

The cost of producing 1 lb. of No. 20's yarn in Bombay, including coal, ranges from $2\frac{5}{8}$ to *3d.* per lb., according to the newness and size of the mill; the cost of production in Manchester is about the same; therefore, in these two respects the mills are equal, but the Manchester mill has to pay, in the shape of interest and other items, about $1\frac{1}{4}d.$ per lb. for bringing cotton from Bombay to the mill-door in Manchester, and about *2d.* per lb. more to get the yarn back to Bombay, which means a clear saving and profit of *3d* per lb. in favour of the Bombay mill. The import duty on 20's yarn into India is barely $\frac{1}{4}d.$ per lb. weight, and suppose this to be abolished, the Bombay spinner has still $2\frac{3}{4}d.$ per lb. of an assured profit arising solely from the expenses saved by spinning in Bombay in lieu of sending the cotton to Manchester.

The production per spindle daily of No. 20's may fairly be taken at $3\frac{1}{2}$ oz. in the best managed Bombay factory.

The waste in working Indian cotton, when not properly cleaned, is, on the average, about 20 per cent., more or less, according to the class of cotton used; in American cotton it is a little less.

Looms and other machinery for weaving yarn into cloth, for which the estimate is given, are adapted to weave shirtings, prints, Madapollans, T cloths, and other cotton goods in most extensive demand in India and China. The counts of yarn most used for weaving this class of piece-goods are 24's warp and 32's weft, which are produced in Bombay factories from Indian cotton. One or two attempts have been made in Bombay mills to import a few bales of cotton from Egypt to use as a

mixture with Indian cotton and produce finer yarns and cloth, but it was found at the time that coarse yarns and cloth paid better.

BOMBAY COTTON-MILLS AND IMPORT DUTIES.

(Extracts from Speeches made at a special meeting of the Bombay Chamber of Commerce, by European merchants engaged in the Manchester trade, 1873.)

Hon. J. K. Bathwell: I do not believe, so long as cotton remains as cheap as it is now, that the Lancashire manufacturer would be able, even if the import duty of 3½ per cent. on yarns and 5 per cent. on goods were removed, to compete. I have been told by agents and directors of the new mills, who have got machinery out on the newest principles, that they are making as much as two annas a pound, or from 25 per cent. to 30 per cent ; the Bombay manufacturer, after paying 3 per cent. on goods exported, is now able to send large quantities of goods to Arabia, Persia, Africa, and China, in competition with the English manufacturer, who has no export duty to pay, except such as may be levied at the ports to which the goods are sent, and to which the Bombay manufacturer is equally liable.

Mr. J. A. Forbes; I am also of that opinion, but no steps should be taken by Bombay merchants to seriously interfere with the only really prosperous branch of industry in the town until we have better arguments brought forward for doing so than have been as yet adduced.

Messrs. William Nicol & Co , of Bombay, to the Secretary B. C. of Commerce: We believe that to abolish import and export duties would give a healthy stimulus to our local industry, exactly as free-trade has done in all parts of the world in which it has been tried. Local millowners have hitherto sold goods much less sized than those which, under the same designation, reach us from Lancashire. Coarse cloths of English make, as long cloth, T cloths, and domestics, and the lower counts of yarns, as 20's, have of late been in a large measure driven out of the market by the local manufacturers: the duty on the English goods has little to do with this. Adulteration of cloth has become a science now-a-days in England, and, although a buyer may be deceived, the wearer of a piece of cloth seldom is deceived a second time, and gives the preference to the honester commodity. The temptation to the local manufacturer to

adulterate is the same as to the English maker, but hitherto he has been honester.

At the Manchester Chamber of Commerce meeting held in April, 1867, Mr. Cassels (now a member of India Council) read the following letter received from his Bombay firm, dated Bombay, March, 1867 —The longcloths, T cloths, and domestics produced by these concerns have been gaining in favour with consumers in all districts where they have been selling during the last two or three years, and are now preferred to Lancashire makes of the same class, mainly because the former, although a rougher, is an honest article, and wears better than the latter.—(Signed) PEEL, CASSELS & Co.

The cotton manufacture in India possesses elements of the highest commercial advantage, because the product is in demand over all parts of India and China, the raw material is near at hand, the processes of manufacture are improving every day, and it could be conducted under very advantageous conditions. It indicates one direction in which industrial activity and commercial prosperity may be successfully pushed.

AN AMERICAN VIEW, MAY, 1874.

It is stated that the time is not distant when the improvements of Indian manufacturers will require the superior American staple, and that it will be exported from this country to Bombay, cheaper even than from New Orleans to Liverpool, because produce ships from India to the United States obtain no return cargo, and will carry cotton at nominal rates. Respecting the profits of Indian cotton manufacturing, we find in the Manchester *Examiner* the following statement of recent returns from nine factories in Bombay:—

	Dividend.
Alliance Mills	15 per cent.
Bombay United Mills	12 „
Bombay Royal Mills	18 „
Great Eastern Weaving Co.	20 „
Manockjee Petit's Mill	16 „
Oriental Mill	24 „

In the growth and prosperity of Indian cotton competition, Manchester manufacturers have been afforded a severe practical lesson of the value of honesty and fair dealing, which it is hoped will be taken duly to heart.—(*United States Economist*, 16 May, 1874.)

DIVIDENDS OF LANCASHIRE COTTON-SPINNING AND WOOLLEN COMPANIES, LIMITED, 1873.

	Per cent.		Per cent.
Albert Spinning, Lim.	24	Melbourne Mill, Lim. . . .	36
Bacup and Wardle, Lim. . .	48	New Church Spinning, Lim. .	18
Bagslate Manufacturing, Lim.	10	Oldham Twist, Lim.	26
Bury and Elton Spinning, Lim.	15	Rawtenstall Manufacturing Lim.	17
Bury Cotton Spinning, Lim. .	10	Rochdale S and M. Co., Lim.	28
Central Spinning, Lim. . .	20	Rosendale S. and M. Co, Lim.	42
Crimble Spinning, Lim. . .	20	Royton Spinning, Lim. . .	40
Croft Bank Spinning, Lim. .	25	Sun Mill, Lim.	15
Green Lane Spinning, Lim. .	30	Shawforth Spinning, Lim. .	17
Greenacres Spinning, Lim. .	15	Weir and Irwell Cotton, Lim	20
Heywood Spinning, Lim . .	24	Windsor Spinning, Lim. .	14
Millgate Man. and Spin, Lim.	22	Whitworth Manufac, Lim. .	24
Middleton and Tonge, Lim. .	30	West End Mills, Lim. . . .	22

COST OF COTTON FACTORIES IN INDIA.

Total Spindles.	Spinning Number.	Cost per Spindle. £	s.	d.	Production (60 hours). lbs.
10,000 T.	10	2	15	5	28,000
10,000 ,,	20	2	5	8	12,500
10,000 M.	20	1	14	2	12,000
10,000 ,,	30	1	9	0	8,000
10,000 ,,	40	1	7	8	5,740
10,000 ,,	50	1	6	8	4,200
10,000 ,,	60	1	5	11	3,166

As per particulars given below.

ESTIMATES, COTTON-SPINNING FACTORIES,

10,000 SPINDLES, SPINNING DIFFERENT COUNTS, FROM NOS. 10 TO 60.

Spinning Nos.	10	20	20	30	40	50	60
Throstles or Mule	T	T	M	M	M	M	M
Cost of Machinery.							
	£	£	£	£	£	£	£
Opners	231	137	137	137	137	137	137
Scutchers	877	585	585	292	292	292	292
Cards	3,514	2,076	2,076	1,438	1,118	956	799
Drawing-frames	767	411	411	310	282	255	201
Slubbing-frames	514	337	337	275	264	257	249
Intermediates	—	618	618	567	557	492	480
Roving-frames	1,211	1,175	1,175	1,131	1,060	1,029	1,009
Throstles	4,435	4,435	—	—	—	—	—
Mules	—	—	2,820	2,820	2,820	2,820	2,820
Reels	527	330	170	141	128	107	93
Total	£12,076	£10,104	£8,328	£7,111	£6,658	£6,345	£6,080
Sundries at 25 per cent.	3,019	2,526	2,082	1,778	1,665	1,586	1,520
Engines, Boilers, Gearing, &c.	8,000	6,400	3,840	3,200	3,200	3,200	3,200
Freight, at 20 per cent.	4,619	3,806	2,850	2,305	2,305	2,226	2,160
Total amount	£27,714	£22,836	£17,101	£14,507	£13,828	£13,357	£12,960
Cost per spindle	**£2 15s. 5d.**	**£2 5s. 8d.**	**£1 14s. 2d.**	**£1 9s. 0d.**	**£1 7s. 8d.**	**£1 6s. 8d.**	**£1 5s. 11d.**
Production of Yarn in lbs. in Sixty Hours							
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Yarn	28,000	12,500	12,000	8,000	5,740	4,200	3,166
Mill Buildings required for each Spindle.							
In square feet	3·4	2·0	3 2	2·8	2·5	2·2	2 0
Spinning Nos.	10	20	20	30	40	50	60

Cost of mill buildings may be calculated at about three rupees per square foot

MACHINERY REQUIRED IN COTTON-SPINNING MILLS,

10,000 SPINDLES, SPINNING DIFFERENT NOS.

Spinning Nos.	**10**	**20**	**20**	**30**	**40**	**50**	**60**
Throstle or Mule	T	T	M	M	M	M	M
			MACHINES REQUIRED.				
Opner	1	1	1	1	1	1	1
Scutcher, with Lap	6	4	4	2	2	2	2
Cards, 44×50	44	26	26	18	14	12	10
Drawing-frames	6	3	3	2	2	2	2
Slubbing	$\frac{4\times60}{240}$	$\frac{3\times50}{150}$	$\frac{3\times50}{150}$	$\frac{2\times66}{132}$	$\frac{2\times62}{124}$	$\frac{2\times60}{120}$	$\frac{2\times58}{116}$
Intermediate	—	$\frac{4\times90}{360}$	$\frac{4\times90}{360}$	$\frac{4\times80}{320}$	$\frac{4\times78}{312}$	$\frac{3\times98}{294}$	$\frac{3\times94}{282}$
Roving	$\frac{8\times136}{1,088}$	$\frac{8\times132}{1,056}$	$\frac{8\times132}{1,056}$	$\frac{8\times124}{922}$	$\frac{7\times136}{952}$	$\frac{7\times132}{924}$	$\frac{7\times128}{896}$
Throstles or Mules	$\frac{36\times280}{10,080}$	$\frac{36\times280}{10,080}$	$\left.\begin{matrix}6\times836=5,016\\8\times624=4,992\end{matrix}\right\}=10,008$ Mule spindles, twist and weft.				
Reels	24	16	18	14	12	9	7
Power required, indicated h.p.	**250**	**200**	**120**	**100**	**100**	**100**	**100**

PRODUCTION FROM COTTON-SPINNING MACHINERY.

Spinning Nos.	10	20	20	30	40	50	60
Throstle or Mule	T	T	M	M	M	M	M
Patent Opner	Up to 35,000 lbs. pei week.						
Double Scutcher	,, 10,000 ,,						
Card	lbs. 650	lbs. 480	lbs. 480	lbs. 440	lbs. 410	lbs. 350	lbs. 320
Drawing	1,100	960	960	800	640	550	530
Slubbing	120	90	90	62	48	37	30
Intermediate	—	36	36	25	19	14¾	12
Roving	26	12	12	8	6	4 6	3·5
Hanks per Spindle	28	25	24	24	23	21	19
Production from 10,000 Spindles	28,000	12,500	12,000	8,000	5,750	4,200	3,166

Mules are calculated to be half twist, half weft; all sixty hours' production.

ESTIMATE OF ONE HUNDRED CALICO LOOMS,

OF VARIOUS WIDTHS, AND PREPARING MACHINERY.

36 looms, 36 in. reed-space complete	£398
20 ,, 42 ,, ,,	227
10 ,, 50 ,, ,,	117
10 ,, 56 ,, ,,	135
10 ,, 60 ,, ,,	149
10 ,, 66 ,, ,,	167
4 ,, 72 ,, ,,	76
1 winding machine, 200 spindles	73
2 warping, with V creels of 500 bobbins	76
1 sizing-machine, complete	193
1 folding and measuring machine	33
1 patent Heald knitting-machine	100
1 cloth press, looming, &c.	66
Packing and delivery	260
Including Accessories £600, Total	£2,783

ESTIMATES OF COTTON-WEAVING FACTORIES,

PER LOOM, FOR

Looms	100			200			300			400		
	£	*s*	*d.*	£	*s.*	*d.*	£	*s*	*d.*	£	*s.*	*d.*
44 in reed-space, at	11	12	6	11	12	6	11	12	6	11	12	6
Winding spindles	0	14	0	0	14	0	0	13	0	0	14	0
Warping	0	14	7	0	11	0	0	9	9	0	9	1½
Sizing	2	0	0	1	0	0	1	6	8	1	0	0
Folding	0	5	6	0	2	9	0	1	10	0	2	9
Heald Knitting	1	1	0	0	10	0	0	6	8	0	5	0
Press	0	10	6	0	5	3	0	3	6	0	2	7½
Looming, &c.	0	3	9	0	2	9	0	2	6	0	2	4
Spooling	0	3	0	0	1	6	0	1	8	0	0	9
Total	£17	3	10	£14	19	9	£14	17	5	£14	9	1
Accessories	4	0	0	4	0	0	4	0	0	4	0	0
Packing, &c.	2	11	8	2	5	0	2	4	7	2	3	5
Stores	2	10	0	2	10	0	2	10	0	2	10	0
Cost per loom	£26	5	6	£23	14	9	£23	12	0	£23	2	6
If	100			200			300			400		
Indicated h.p required	25			50			75			100		
Cost, engine, boilers, &c.	£8	0	0	£8	0	0	£8	0	0	£8	0	0
Total cost per loom	**£34**	**5**	**6**	**£31**	**14**	**9**	**£31**	**12**	**0**	**£31**	**2**	**6**

Space required for weaving-shed per loom will be about 75 square feet, or, including engine, warehouse, &c., 90 square feet.

Machinery. 200 winding-spindles, and 2 warping, will be required per 160 looms, one sizing-machine will suffice for 200 looms.

COTTON-WEAVING FACTORIES:

CONSUMPTION OF YARN, PRODUCTION OF CLOTH PER LOOM IN SIXTY HOURS.

Cloth.	Width in Inches	Length in Yards.	Reed Pick. in ¼ inch.	Weight.		Will weave up Twist		Weft		Production per Loom
				lbs	ozs	No.	lbs	No	lbs.	yds
T Cloth . . .	32	24	12×12	5	0	20	$27\frac{1}{1}$	26	21	**285**
Longcloth . . .	40	36	12×12	10	0	20	$33\frac{1}{2}$	22	29	**260**
Domestics	29	70	8×9	18	0	10	45	16	$32\frac{1}{2}$	**335**
Shirting	39	$37\frac{1}{2}$	16×15	8	4	30	25	36	19	**232**
,, . .	39	$37\frac{1}{2}$	14×13	7	0	30	27	36	20	**278**
,, . . .	36	40	14×13	7	0	30	$24\frac{1}{2}$	34	$19\frac{3}{1}$	**288**
,, ...	36	40	16×15	8	0	30	24	34	$19\frac{1}{2}$	**247**
Printers	26	30	16×16	3	0	40	$14\frac{1}{1}$	50	$11\frac{1}{1}$	**278**
Maddopolams . .	32	24	12×12	3	8	30	$18\frac{3}{4}$	30	$18\frac{3}{4}$	**296**
Jacconets	39	20	14×14	2	8	40	$18\frac{1}{4}$	60	$13\frac{1}{4}$	**288**
Mulls	45	20	16×15	2	1	60	14	90	9	**247**

ESTIMATES FOR BLEACH, FINISHING, AND DYE-WORKS MACHINERY.

The bleach-house machinery is adapted to bleach more than 2,500 pieces of 20 yards each per week. The cost of bleaching in England is from 8 to 12 pence per piece of 38 yards, according to finish and width.

In the dye-house, 6 indigo vats will dye 15 pieces of 50 yards each per day, of the best genuine indigo blue; double of medium quality, or 90 pieces of common topped blue, topped with logwood. Dyeing in indigo is very simple; all the styles are cheap, possessing extraordinary stability; its chief consumption is among the poor classes. In facy dyeing, two jiggers will dye 20 pieces per hour of slate, drab, or lead colour; or 40 pieces of black, brown, &c. In fact, the quantity will depend on the quality and the style of colour. In Turkey red dyeing, the bleached yarn, after some preparatory processes, is boiled with madder root or munjeet. Fictitious Turkey reds are abundant, approach genuine colour, but are unable to resist wear and washing.

The finishing machinery for starching and glazing the piece-goods is so adapted as to finish the goods that may be either dyed or bleached.

There is ample room for introducing improved machinery specially for dyeing purposes, as the dye-stuffs are produced in large quantities in India.

Machinery for Bleach-house.

	£
1 singe stove, copper singe plates, rollers, framing, complete .	144
2 keirs; 1 washing machine; 4 squeezers, rolls, 1 chemic machine, &c.	561
1 drying machine, with steam cylinders, pressure gauge, &c. .	240
6 steam-engines, complete, pipes, valves, and taps	997
	£1,942

Machinery for finishing Works.

	£
2 water mangles, 6 and 3 rolls; brass spreading-rollers, &c. .	1,700
2 starching mangles, 1 stretching, 1 damping, 1 conroy, &c. .	1,042
1 finishing calender, 5 rolls, double batching arrangements .	677
7 steam-engines for driving above machines	1,200
1 hydraulic press, boiler, blowing fan, heating cylinder . .	1,075
	£5,694

Machinery for Dye House.

	£
2 wetting cisterns, 8 iron jiggers, 6 indigo vats, 3 ash vats, rollers, steam-engines for driving, &c.	1,020
1 padding machine, 2 brass rolls, steam-engine for driving .	180
2 drying machines, 2 mangles, 2 steam-engines, &c. . . .	902
Rasp for cutting dye-wood, 6 mills for grinding indigo, 2 steam-engines, &c.	856
	£2,958

It is of great importance that works for bleaching, dyeing and printing should be erected where pure soft water may be had in abundance. The engraved copper rollers of patterns generally weigh about 120 lbs. each, the price of which varies. Printing by the cylinder machine is executed, not only with greater accuracy than by the wooden hand-block as practised in India up to this day, but with an almost incredible saving of time and labour. A single machine, with one man to regulate the engraved pattern rollers, is capable of printing as many pieces as 200 men could do with the hand-block in the same time. In one minute 28 yards of calico has been printed in four different colours. The styles of calico printing are numerous, but the most important and the most extensively practised, forming the bulk of the cotton prints, is the madder style. Not only does it yield a great number of beautiful shades of colour, but they are all of the utmost degree of permanency,—fast colours, resisting wear, friction and washing.

The reduction in price of cotton prints within the last fifty years is a striking illustration of the advancement which has been made in Europe in calico printing.

ESTIMATE FOR CALICO PRINT WORKS MACHINERY.

	£
Bleach-house machinery, with shafting, winces, &c. . . .	1,870
Engraving-room machinery, including 2 engraving machines	1,338
Printing machines, 1 for printing in 1 colour, 1 for 3 colours, 1 for 4 colours, 1 for 6 colours, 4 steam-engines, &c. .	2,720
Colour machinery: a set of double-cased copper colour-pans, with all steam and water pipes, grinding rollers, &c., with fittings complete	670
Madder dye-house machinery, complete	2,530
Finishing-room machinery, complete	1,510
Steaming-house machinery: wrought-iron carriage, indicator, &c.	180
Carried over	£10,818

Brought over . . .	£10,818
Mechanics' shop: 2 lathes, 1 planing, 1 drilling, &c . .	800
2 steel boilers, for supplying steam to all the works . .	1,460
Accessories and extras, including 100 engraved copper rollers	1,250
	£14,328

Buildings required, square feet 29,453, cubic feet, 529,254.

ESTIMATES, JUTE FACTORY.

In India, jute manufactures must be placed next in importance to cotton, on account of the large consumption both in India and in other foreign countries. The jute plant is most extensively cultivated in Bengal. Its culture is easy, and the production comparatively large. In Great Britain jute has only been known within the last quarter of a century. Machinery worked by steam has been applied, as in cotton goods, to spin and weave jute, whereby the production has been largely increased.

The various descriptions of jute goods manufactured in these factories are baggings, sackings, hessians, sheetings, ducks, carpeting, &c. The major portion of the jute cloth is made of yarn in the green or natural state; but in many sorts the yarn is bleached, dyed, and finished.

There are about a dozen jute factories near Calcutta, for spinning and weaving jute into baggings by improved machinery; these have been erected recently, chiefly with English capital. These factories have yielded handsome returns to the proprietors. In Dundee alone nearly 50,000 tons are manufactured into bags and sacks annually, the raw material of which is exclusively supplied by India.

ESTIMATE OF JUTE MACHINERY FOR MAKING BAGGINGS, SACKINGS.

150 *Looms and* 3,078 *Spindles.*

2 softening, 1 teazer, and 1 waste card		£1,094
System for Warps.	*System for Wefts.*	£
3 breaker cards	4 breaker cards . . .	1,655
5 finisher cards	5 finisher cards . . .	2,623
10 drawing, 1 and 2nd. . . .	8 drawing, 1 and 2nd. .	1,908
	Carried over . . .	£6,186

System for Warps.	System for Wefts.	
	Brought over	£6,186
5 S roving, 56 = 280 sp. . . .	4 roving, 224 sp. . . .	3,692
9 D. spinning, 64 = 1,152 . . .	6 D spinning, 48 = 576 .	7,493
9 D. ,, 4 t. 60 = 1,080 .	3 D. ,, 6 t. 45 = 270 .	
Spindles, warps, 2,232 + weft, 846 = 3,078.		
7 D. warp winding sp 238 . . .	5 D. cop weft, 300 . .	1,379
5 beaming for 36 and 42 looms .	1 beaming for 53 and 60 l.	482
40 looms, plain . . . 36 R. S.	25 plain, 42 R. S. . .	5,908
40 ,, 3 twilled, 36 R. S.	10 ,, 53 R S. . .	
25 ,, ,, 42 R. S	10 ,, 60 R S .	
2 sacking calenders	1 sack-cutting machine .	544
3 pairs sack sewing	4 balling machines . .	495
400 *I.* h. p. Corlis engine to drive spinning		4,628
100 ,, ,, for looms, &c		
4 C. steel boilers to work from 100 to 150 lbs. p. . . .		2,800
Mill-gearing tools, extras, &c.		7,000
		£41,701

Buildings required, square feet, 70,700, cubic feet, 84,800.

EXPENDITURE AND RECEIPTS, JUTE FACTORY IN INDIA.

Expenditure, 12 *Months.*

	£
Wages. Europeans: 1 manager, £800, assistant, £400; engineer, £350, &c, and including 850 native workers . .	15,000
Coals, 60 tons per week, at 50*s.* per ton	7,500
Oil for batching, for lubricating	3,375
Rates, taxes, and insurance	450
Depreciation of machinery	1,500
Interest at 9 per cent. on £75,000 outlay	6,840
Jute, 45 tons per week, at £12 per ton	27,000
	£61,665

Receipts, 12 *Months.*

Production from 150 looms, say 99,750 yards of cloth per annum, averaging 16 oz. per yard, at $3\frac{1}{2}$*d.* per yard . £72,750

Nett profit in 1873 about 16 per cent. The average nett profit per ton of jute manufactured is £3, when trade is very healthy £5 per ton.

FACTORY FOR SILK GOODS

FROM WASTE AND NEAT SILK.

Waste silk means the parts of the cocoons that will not wind properly into neat silk, such as pierced cocoons, double cocoons, also the waste in reeling, winding, &c. Special machinery has been introduced within the last few years for working up this material into yarn, and is specially adapted for Indian silk

waste. It would be profitable to work up in India chasums and tasar by silk-waste machinery in conjunction with neat silk, as per estimates given.

Waste silk is prepared either by the short or long spun system. By the short it is carded on cotton cards and spun on mules, but by the long system yarn is produced of a quality which is worked into the finest silks, velvets, ribbons, sewing thread, &c., and is largely used in Lyons. In Italy a good deal of Indian waste is worked up. The yarns prepared, dressed, and spun from waste silk are very well adapted for weft.

Some class of Indian goods, such as Gungeanee, can be produced entirely from waste silk yarns. Silk waste sells in India at about 2*s.* per lb., and is largely exported from Calcutta.

On account of gum, dirt, &c., the waste in working is nearly 60 per cent. The disadvantage of its manufacture is, it requires in machinery four times more outlay of capital than neat silk; but very great advantage lies in working a material, the price of which, compared with raw silk, is trifling. In India it will be found by far more profitable than neat silk.

In England, 4*s.* 6*d.* to 5*s.* is the cost of producing a pound of silk yarn, 260's (or 120 double cotton count) made from waste silk, plus the wastage in working, and the yarn, which is very even, fetches from 18*s.* to 24*s.* per lb. In India, the cost of manufacture will not exceed what it is in England, from the fact that in Bombay in the cotton mills, and in Calcutta in the jute mills, cotton and jute yarns are produced just at the same cost as in England.

The hands required will be about 60 in waste silk department, for neat silk 30, for weaving and preparation 150, total about 275.

The quantity of silk yarns per week from waste-silk machinery will be 300 lbs. fine Nos., or about 600 lbs. heavy Nos., from neat silk about 150 to 300 lbs. The cost of throwing neat silk is, in England, from 3*s.* 6*d.* to 4*s.* for weft, and 6*s.* to 6*s.* 6*d.* per lb. for warp. For weaving, about 6½*d.* per yard.

The production of cloth from each loom per week will be from 50 to 70 yards, according to the quality of the cloth. Fifty yards, 26 to 28 inches wide, will weigh 5 lbs.; about 500 lbs. yarn will be required for 100 looms; estimated, therefore, the excess of yarn will remain for selling in the market. If not required for that purpose, an addition of 100 looms will use up all the yarn produced for making silk goods.

Silk machinery is light, takes little power to drive compared with cotton or jute. In estimates, ample provision has been made for extra power. The area for buildings in square feet required will be, for working waste-silk machinery, 18,900, for neat silks 16,800, for looms 11,300, and including engines, &c., about 51,000 square feet.

The importance of the silk-waste manufacturer may be judged from this fact, that for one pound of the best silk wound direct from the cocoons 12 to 14 lbs. remain, which can only be worked up into yarns satisfactorily and profitably by special machinery for which we have given estimates, and which produces yarn admirably adapted for wefting silk goods.

ESTIMATE OF WASTE SILK MACHINERY IN CONJUNCTION WITH NEAT SILK

		£
Machinery to Dress and Spin Waste Silk.		
1 washing machine	1 stampede	
1 cocoon-opener	1 hydro-extractor	800
1 filling for frisons	1 for cocoons	
6 flat dressing-frames, 3 circular		1,788
For First Drafts.	*For Shortest Drafts.*	
1 I. gill spreader	1 napping machine	
4 intersecting spreader	1 set patent gills	
2 s. g. drawings	2 s gill drawings	2,764
2 roving f. 72 spindles	1 roving f 36 spindles	
8 spinning-frames, 300 each, total 2,400 spindles		
4 twisting " 272 " " 1,080 "		4,430
2 D. reels, 50 each side	1 bundling press, &c.	
Extras and accessories, waste silk		900
Silk-Throwing Machinery		
8 winding-frames, 84 each, total 672 sp.		
7 " " 90 " " 630 "		
2 doubling " 82 " " 164 "		1,100
5 band spinning-mills, 200 each, total, 1,000 sp.		
Extras and accessories, throwing-mill		500
Weaving and Preparation.		
2 Pirn winding, each 100 sp.	4 drawing	
4 warping-mills	1 punching for Jacq	990
10 picking-frames	extras for looms	
20 plain silk looms, 28 in., reed space		319
40 looms, fitted for 5 salten tappets		814
20 " " with demi-Jacquard		451
20 " " with Jacquard apparatus		500
Condensing steam-engine, 2 steel boilers, shafting, pulleys, belting, tanks, &c.		5,000
		£20,356

SERICULTURE IN INDIA.

(Official Account, Progress Report, 1871–72.)

No active measures have been taken for the promotion of this industry. The quantity exported from Bengal has not varied in the last thirty years, being about 1,500,000 lbs., but the price has nearly doubled. The cultivation in Bengal is mainly carried on in the districts of Rájsháhi, Birbhúm, Meldah, Murshidabad, and in Assam. In Rájsháhi there are 97 filatures, having 5,760 basins, and employing 10,000 hands. The yield of raw silk is 5,000 maunds, and 150 square miles are under mulberry cultivation. In Birbhúm the silk industry, of an annual value of £160,000, supports 15,000 persons. In Assam the mulberry is grown in small patches, two kinds of worms are reared, and a fine white silk is produced. A very considerable quantity of tasar silk is raised in the Chattisgarh country, in the Central Provinces, the worms being fed on the sál tree. The only other province where sericulture is practised to any extent is Mysor, where the mulberry gardens occupy 31 per cent. of the cultivated area.

There is, however, another branch of the industry connected with the wild spinning insects of the jungle, called tasar and eria. In 1858, Dr. Birdwood proposed the utilisation of the wild worms found in the Bombay Presidency, and, in 1856, Captain Hutton, of Masúri, represented the existence of certain wild silk-worms in the Dehra Dun. The tasar insect is found all along the sub-Himalayan range, and in forest-covered hills to the south of the Ganges, and it has for centuries been an article of trade. It feeds on the sál, the jujub, a *Terminalia*, and other forest trees, and the seed is purchased from the jungle people by the rearers, who raise the worms on trees. The tasar silk is much used in native fabrics. (Pp. 31, 32.)

Baboo Ramchunder, sen., deputy-collector of Jessore, reports:—"One seer of the *palu* (seed worm) yields 30 to 40 seers of cocoon, which, when put to the reel, produce about 1½ seer of silk, valued 2½ rs. 14, 15, or 16 per seer. A maund of cocoon usually yields 2 to 2½ seers of silk, 2 seers being the usual quantity. The expenses are—One seer of *palu* (seed cocoon) 1 r. 2 as., mulberry leaves, one season, 16 rs.; mats, 9 as.; spinning, 1 as.; commission to mahajun, 12 as.; total, 19 rs. 7 as. This is exclusive of the ryot's labour, both he and his wife being constantly engaged in rearing the worm and supplying the leaf.

SUGAR FACTORY.

The size of a sugar factory will depend on the size of the estate, &c. A sugar factory only works for a certain period during the year; but then it works both day and night. The estimates given are for a moderate-sized sugar factory, which will be applicable in a great many cases. The weight of canes from one acre varies, according to soil, culture, and climate, from 20 to 30 tons.

The composition of the best sugar cane is thus given.—70 per cent. water, 20 per cent. sugar, other matters 14 per cent. In practice no more than 80 per cent. of the juice is pressed out.

Cane juice, when at its best, gives 10 to 12 per cent. of sugar, or about 1¼ lb. of crystal sugar per gallon.

The yield of solid sugar per acre, as a fair specimen, is calculated at 4,000 lbs. But, owing to defective culture and the injurious mode of expressing and evaporating the juice in India, the yield in Bengal per acre is only 2,600 lbs. of khaur sugar, and 2,000 lbs. of molasses, and of such inferior quality, that if khaur sells per Bengal maund at the rate of 4 rs., molasses would not fetch more than 12 annas. The means by which a better result is to be attained will be by the use of improved cane mills, and improved machinery driven by steam.

The estimate for a sugar factory includes all machinery for producing well-formed and dry crystals of sugar, and sugar of a quality required for local consumption in India and for export to Europe.

The sugar-mill will crush about six tons per twelve working hours; 70 and even 80 per cent. of juice will be obtained.

The concretor will turn out at the rate of 900 lbs. per hour. It has been stated that 1 gallon of cane juice will produce about 2 lbs. of concrete sugar in weight.

In sugar-mills, the trash from the canes, called megass, is generally used as fuel after being dried in the sun, by which it loses half its weight; 2 lbs. of dry megass is nearly equal to 1 lb. of coal.

The total cost of all machinery, buildings, iron roof, charges for erection, and putting in complete working order, may be put down at £20,000. Copper enters largely into the composition of sugar machinery, and therefore the machinery is costly.

For pure white loaf sugar, additional machinery will be required beyond that specified, consisting of bag and charcoal filters, &c., which will cost about £1,300 additional. In a factory where the operations of sugar refining are to be pushed to the highest point for producing pure white loaf sugar, a very large quantity of animal charcoal is quite indispensable. Charcoal entirely removes colour from the sugar solution, making it as colourless as pure water. In England one ton of charcoal is used to purify one or two tons of sugar, according to quality.

But, unfortunately, in a very short time, from 24 to 72 hours, the power of the charcoal becomes exhausted. It is restored again by heating it to redness in furnaces.

A sugar refinery for producing pure white loaf sugar will not pay in India unless fuel is cheap. Any varieties short of loaf, could, under a proper application of machinery, be more profitably manufactured in India.

Rum is distilled in some sugar factories from molasses and other impurities, but large copper stills and refrigerators are required for the purpose.

ESTIMATE FOR MACHINERY FOR MANUFACTURING CRYSTAL SUGAR.

	£
A sugar-mill, strong and powerful, 3 rollers 26″ diameter, 4′ 6″ long, &c. Horizontal steam-engine for driving, complete, with double gearing; cane-carrier, megass-elevator, &c.	2,500
3 Steam clarifiers, 200 gallons each, copper tubes, &c.	600
1 Concretor, including trays, copper revolving cylinder, drum, self-acting fan, pump, engine, &c.	1,500
Copper vacuum pan, 6′ diameter, 5′ 6″ deep, with jacket. A vacuum-pump steam-engine. Cast-iron staging, iron stair, rails, plates for flooring, complete	1,900
3 centrifugal machines, for making sugar in crystals, with a separate steam-engine for driving each machine, &c.	650
1 iron tank for liquor from clarifier, 1 cistern to receive syrup	90
2 steam boilers, complete, with safety-valves, dampers, &c.	950
Steam, feed, and water pipes, packing and delivery	1,200
	£9,390

Factory buildings required 6,242 square feet, or 12,500 cubic feet.

ESTIMATES, PAPER FACTORY.

Paper-mills in Europe generally work day and night, or 132 hours per week.

The waste in working rags, &c., in the several processes of dusting, washing, boiling, and reduction to half stuff, will be in proportion to the quality of rags. For very fine white rags about 10, for coarse 13, for coloured 18, and for old pack-cloths and ropes from 20 to 30 per cent., is the approximate average of waste. In boiling rags, lime or soda is used, the choice depending entirely on its cheapness.

In sizing a certain class of printing-papers, animal gelatine, made from the parings of bullock or buffalo hides, with a mixture of alum dissolved in it, is used, and placed in a trough between the drying cylinders of the paper-making machine.

Water for the manufacture of paper will be required in abundance, and that of a good quality: about 80 cubic feet per minute, besides the quantity for steam-engine. In the production of fine paper the quality of the water is very important, and it is for this reason that paper-mills in Europe are widely scattered, being generally built near pure streams of water.

Water power may be employed in driving the machinery for preparing the half stuff for making paper, if the fall of water near a stream is sufficient, and to be relied on at all seasons, which is not generally the case. The paper-making machine is invariably driven by a separate small steam-engine attached to it, as it requires a perfectly regular motion; and the waste steam is employed in heating the cylinders for drying the paper.

The cost of machinery, buildings, &c., estimated, may be roughly calculated at £30,000. For brown paper, the consumption of coal and lime will be less than for white paper.

In Great Britain in 1870, there were 350 paper-mills, employing each on an average seventy-five hands. There are more paper-mills in America than in Great Briton.

ESTIMATE OF MACHINERY FOR A PAPER-MILL.

	£
1 Rape cutter, 1 rag duster, 1 willow	346
2 Revolving rag boilers, complete	600
4 washing engines, cast-iron troughs, complete .	975
Bleaching chests, fittings, press for half stuff	440
4 Beating engines, 80 steel bars in each roll	1,250
Iron girders, pillars for rag engines, shafting, &c. . . .	1,020
1 Paper-making machine to make paper 72 inches wide, complete with stuff chests, knotter, oscillating frame, guide rolls, vacuum boxes, 10 steam cylinders for drying, 1 smoothing calender, including steam-engine, &c. . .	3,800
1 Paper-cutting machine, 1 press, complete	450
1 Condensing engine, 300 *I* h.p., steel boilers, economizer, extras, packing, &c.	6,500
	£15,381

Buildings required for mill, 25,000 square feet, or 371,000 cubic feet.

Expenditure, Paper-mill, per Annum.

	£
Jute cuttings and white rags, 26 tons per week of 132 hours, at £10 per ton	15,400
Lime for bleaching, boiling	1,100
Wages and salaries	2,500
Coals 80 tons per week, at £2 10s per ton	10,000
Felts, jackets, and wire, for paper machine	400
Coal or oil gas lights, tallow, oil	1,500
Depreciation and insurance	1,000
	£31,900

Receipts, Paper-mill, per Annum.

Paper produced, fair quality of printing paper, 16 to 18 tons per week of 132 hours, or 2,160,000 lbs. per annum, at 4*d.* per lb.	£36,000

ESTIMATES FOR IRON-FOUNDRY AND WORKSHOPS.

It is in the iron foundry and the smithy that the iron is converted into several required forms, either by casting it in the foundry, or in the smithy where the pig-iron is turned into malleable bar iron. Then it is shaped into different forms by various machines designed for the special work: a good many improvements have been introduced; viz. scraping by machinery for obtaining true surfaces, for accurate measurements, whereby a difference in length or thickness of one-millionth part of an inch may be detected, by adopting a uniform system of screw threads, &c. These several machines for working in iron, brass, and other metals are self-acting, work with great precision and extreme accuracy, and are adapted to the nature of the work, whereby the need of skill and dexterity in the workman is not so indispensable. Besides repairs and making good any break-down in the machinery, the foundry workshops will be capable of turning out new steam engines, boilers, and new machines of a moderate size, complete in every respect, and similar to those made in English establishments.

ESTIMATES FOR AN IRON FOUNDRY AND MACHINE WORKSHOPS.

Iron Foundry.

	£
1 Cupola fittings, complete	345
1 Fan, 42" complete	76
1 Grinding-mill	375
1 Travelling crane, span 40	420
Miscellaneous including a 3-ton ladle, 5 small ladles, 6 lifting chains, core-carriage, stove-door, &c.	309

Smithy and Boiler Shop

6 Smiths' hearths	463
1 Fan, 22"	45
1 Plate-bending machine, 6'	361
1 punching and shearing machine	234
1 Steam hammer	292
Miscellaneous, grindstone complete, 6 sets smiths' tools and hammers, boiler-makers' tools and hammers, anvils, blocks, stands, &c.	829

Turning and Erecting Shop

1 Slide break lathe, to take in 20 ft. between centres	706
1 Slide and screw-cutting lathe, bed 20 ft. long	311
1 Slide screw-cutting lathe, bed 15 ft long	231
1 Slide screw-cutting lathe, bed 12 ft long	193
1 Hand-turning lathe, bed 16 ft. long	174
1 Hand-turning lathe, bed 14 ft long	138
1 Hand-turning lathe, bed 12 ft. long	118
1 Planing machine to plane 12 by 4 6 by 4 6	634
1 Planing machine, to plane 6 by 2 6 by 2·6	222
1 Vertical drilling machine, to admit 3' 8" diam, double geared	
1 Vertical drilling machine, to admit 3' 0" diam, single geared	97
1 Radial drilling machine, 8 feet radius	502
1 Radial drilling machine, 4 ft 6 in. radius	198
1 Shaping machine, stroke 12½"	210
1 shaping machine, stroke 9"	144
1 Slotting machine, stroke 18"	
1 Slotting machine, stroke 12"	214
1 Vertical boring machine	499
1 Screwing machine	145
2 Grindstones, with frames	112
Miscellaneous, including sets, drills, and steel tools required for the machine tools, chipping hammers, steel chisels, cylindrical gauges, and sundries	304
1 High-pressure steam-engine, boiler, gearing, shafting, pedestals, strapping, &c. Packing and free delivery on board a vessel	4,018
	£12,751

ESTIMATES, TIMBER MILL.

In the estimates the price of each machine is given separately; so that machinery for working in timber may be erected on any scale, and any items omitted from the estimates which may not be required. Thus timber-mills may be erected of any size, and from £500 and upwards, and fitted with machines adapted for any special work. Each estimate is complete in itself, taken separately, with its steam-engine and boiler, or the whole may be combined together as one, for a large town.

The area of buildings required will be 14,440 square feet, or 17,200 cubic feet.

ESTIMATE OF MACHINERY FOR A TIMBER-MILL.

	£
1 Timber frame, 36 inches, for cutting logs into boards	560
1 Planing machine, 5 × 12, for jointing, tonguing, grooving	442
1 Moulding machine, 3 × 9, 1 set of cutters, complete	176
1 Veneer sawing machine, with 10-feet disk, complete	247
1 Plain saw-bench, a saw 42 inches diameter	105
1 Steam-engine, 75 *I.* h.p.; 1 boiler	1,400
Extras and sundries	500
	£3,430

Estimate for Window and Door Machinery.

1 Machine, for planing and squaring, 18 × 18	245
1 Cross-cut saw-bench, self-acting, including 2 saws	70
1 Circular moulding machine, for circles and irregular shapes	80
2 Double tenoning machines, 6 cutters, complete	327
1 Vertical boring machine, for boring holes 3″ diameter, 16″ deep	73
1 Saw-bench, for sawing, tonguing, &c., parallel fence, &c.	95
1 Steam-engine, 50 *I.* h.p, 1 boiler, gearing	1,358
Sundries, packing, &c.	350
	£2,598

Estimate for Packing-case Machinery.

1 Cross-cut saw-bench, complete, including 2 saws, 16″ and 18″	76
1 Plain saw-bench, complete, including 2 circular saws	40
1 Steam-engine, boiler, shafting, belts, sundries	450
	£566

ESTIMATES, OIL MILL.

Not more than ten hands are required in a mill of two double presses. The total cost of oil works in India may be put down under £10,000.

The oil-mill, with two presses and sixteen boxes, for which the estimate is given, will, by working ten hours a day, crush 9,360 quarters of Bombay linseed per annum. The production of linseed oil will be (say) 564 tons, and of linseed cake 1,174 tons. A ton of oil, linseed or rape-seed, contains 240 gallons, and occupies $38\frac{1}{2}$ cubic feet. A cistern $8 \times 8 \times 6$ feet will contain 2,393 gallons. Oil-mills in England generally work day and night.

The following are examples of profits nett. derived in England.—

Bought, per quarter.	Oil sold, per ton.		Oil Cake sold, per ton.		Profits, 12 months.
s.	£	*s*	£	*s.*	£
		LINSEED.			
52	28	5	9	10	1,528
56	30	0	10	0	1,230
72	45	0	10	0	2,202
66	37	10	9	10	1,193
59	31	0	10	10	977
per ton.		COTTON-SEED.			
160	31	0	5	5	4,046
per quarter.		RAPE-SEED.			
67	49	0	5	15	2,333

Rape-seed oil, after being purified, is largely used in England for lubricating machinery; for which purpose it is in great demand, the demand increasing with the extension of machinery.

ESTIMATE OF MACHINERY FOR OIL-MILL.

	£
Elevator, a pair of rolls for crushing seeds	214
Cocoa-nut rasping machine (if required)	180
Decorticating machine for cotton seeds	150
Grinding-stones, for grinding seeds, weight 10 tons . . .	260
Steam-kettle for heating seed-paste, with stirrers .	101
Bagging for containing heated seed-paste for pressing, 32 hairs	350
Two double hydraulic presses for expressing oil, 16 boxes, patent double pumps, indicator, complete	1,054
Four oil cisterns, $6' \times 8' \times 8'$, with glass indicators, a force-pump	205
Steam-engine, 75 *I.* h.p., boiler, gearing, &c	1,500
Miscellaneous and extras, packing, &c.	300
	£4,314

Space required, 3,000 square, or 37,000 cubic feet

OIL GAS.

In several places in India, the manufacture of gas from oil will be advantageous, besides being an admirable means of using up impure oil, refuse fat, and such other materials. The illuminating power of oil gas is twice as that of ordinary coal gas. The process of making it also is much more simple, requiring less purification. The oil is decomposed by a slow red heat, and is converted into illuminating gas and tar.

One gallon of oil will yield 80 cubic feet of rich gas.

The cost of oil gas in India, as tried for several months, is 16*s.* 6*d* per 1,000 cubic feet from cotton-seed oil. Each burner will consume $1\frac{1}{2}$ cubic feet of oil gas per hour: for the same intensity of light 3 cubic feet of coal gas would be required.

The cost of gas apparatus is about £1 per each burner, from 10 to 1,000 burners, and upwards.

ESTIMATE OF MACHINERY FOR A CORN-MILL.

	£
2 Corn elevators, 1 smut or corn clearing machine	132
3 Pairs grinding stones, 48 inches diameter, complete . .	502
1 Flour elevator, 1 dressing machine, with silks, &c.	160
1 steam-engine, 1 boiler, 50 *I.* h p , &c.	850
Gearing for stones, upper and lower, &c. . . .	224
Fan, crane, sacking cylinders, &c.	202
	£2,070

Space required, 2,975 square feet, or 57,600 cubic feet.

In most English mills the diameter of the millstones is 4 feet, and their thickness about 12 inches. For wheat one stone is composed of French burr, which is very hard but porous.

The production of flour from the mill for which the estimate is given will be 156 bushels of wheat every ten hours. It has been stated that in many corn-mills in England, fitted with the most improved machinery, each pair of stones grinds even more, of coarse flour.

SMALL WORKS—ESTIMATES OF MACHINERY.

	£
20 Cotton gins, double-action Macarthy, 40″ wide; 2 seed-openers, shafting, &c., each gin will turn out per hour 20 lbs. of clean cotton and upwards	650
Steam-engine boiler, to drive all gins, or any of the following machines	600
1 Oil-mill, complete for working 25 quarters of linseed, cotton, or rapeseed	1,200
2 Corn-grinding mills to grind 3½ bushels per hour	350
1 Portable log frame, to take logs 25 feet in length, 14″ diameter	410
1 Wool-washing machine, 3 rakes, squeezers, will wash 4,000 lbs. wool per day	300
1 Wool-drying machine	225
Power required to drive wool machines, 5 *I* h. p.	
Rope and cordage machinery, requiring 25 *I* h. p. to drive	800

Portable Brick-making Machines

	£
Crushing, pugging, and brick-making machine, with dies and wire cutting, producing about 100,000 bricks per week, by *wet process*, complete, with steam-engine, boiler, &c.	1,200
Second-size machine, 75,000 bricks per week	760
Third-size machine, without crusher, for clay free from stones, producing 9,000 bricks per day, arranged for animal power	400
Machine for tiles and pipes, also for solid or hollow bricks, worked by animal power	120
Tile pressing machines . . . from £50 to Mortar and loam mills . . . „ „	150
Machine with pug mill, revolving table, moulds, steam-engine, boilers, with all fittings complete, capable of making 10,000 bricks per day by *dry process*	1,200
Clay crushing rollers, 20 to 25 in. diameter, complete from £50 to	150
Combined rollers with pug mill . . . from £100 to	225

Steam pile-driving machine, to drive 30 ft. long	275
Winding and pumping engine, 3 h. p., for pile-sinking	250
Patent clips for self-acting inclines	100
Centrifugal pump to raise 500 gallons per hour, or with 5 h. p. portable engine	350

STEAM AGRICULTURAL MACHINERY,

Adapted for letting on Hire, or for large Farms.

	£
Steam cultivator, with ploughing apparatus, &c., portable steam-engine for working on the single system . .	1,200
Ditto, for working on the double system	2,500

A double set of 14-horse power tackle will plough on light land about 16 acres per day, or on heavy land from 8 to 10 acres. It will cultivate from 15 to 20 acres, but if the fields are light, and the land has been well prepared, 20 or 30 acres is the average amount of work which can be got through. Ploughing may be accomplished on either light or heavy land to a depth of 15 inches, but it requires special implements for the purpose; the usual depth is 8 inches to 10 inches. The Cultivator can be made to work at a depth of 24 inches, but the usual depth is from 12 inches to 15 inches. The actual cost of ploughing, in England, an acre of heavy land 8 inches deep will be about 7*s*. 6*d*., and the estimated cost of ploughing deeper is about 1*s*. per inch per acre. On light land the cost per acre, at 8 inches deep, would be about 4*s*. The cost of cultivating an acre of heavy land, at about 12 inches to 15 inches deep, would be about 5*s*., and on light land 2*s*. 6*d*.

The increase of produce on steam cultivated land is about one-fourth. Sugar-cane, cotton, maize, have been found to improve considerably on steam-cultivated soils.—(Messrs. Ramsome and Sims, 1871.)

A point of importance on strong land is the effect of steam cultivation on drainage and produce. In many cases the increase has not been sufficiently marked to be visible to the eye, whilst in others from 4 to 8 bushels per acre is the estimated increase of corn crops, and such a result would add materially to the profits on steam.—(*Journ. Agricultural Society of England*, July, 1867.)

	£
Steam thrashing machines, adapted for hot climates, for thrashing grain and bruising straw, from 25 to 68 bushels . . . . from £380 to	600
Disintegrator for pulverising sun-dried bones, or preparing other materials for manure	160
Steam-engines, portable, with boiler complete, from 6 to 20 h. p. to indicate 3 times the *I* h. p., will give per nominal h. p.	45

COST OF WATER-WHEELS.

A Turbine, equal to 10-horse power, with a good sufficient supply of water with from six to ten feet fall, costing about £100, would, with a fall of thirty feet, be reduced to half that cost. To prepare estimates it is necessary to know the height of fall, the maximum and minimum quantity of water available, and the horse power required.

COST OF FACTORY BUILDINGS IN INDIA.

	Rs.	a.
Excavation for foundations, per 100 cubic feet	1	0
Excavation for two wells, 20 feet deep, per ditto	2	8
Rubble work for foundations, per ditto	18	0
Upper rubble work, per ditto	20	0
Brickwork for walls, boiler, and engine-beds, chimney, 15 feet high, per ditto	35	0
Brickwork in chimney, height 80 feet, per ditto	60	0
Brickwork in arches in engine-house, &c., per ditto		
Firebrick-work, labour only, at different prices, per ditto	10	0
Plastering the walls, in and out, per 100 superficial feet	8	10
Teak doors, panelled, per c. f.	1	12
Teak boards under iron sheets of roofs and brackets, ¾ inch thick, per ditto	25	0

The cost of factory buildings in India may be calculated at about Rs. 3 (6*s.*) per square foot of space occupied by mill buildings. The above prices of work are for Bombay, where labour is dear. The cost of government public buildings in Bombay is 5 annas per cubic foot, or Rs. 3.12 per square foot.

APPENDIX.

MEMORIAL OF THE MANCHESTER CHAMBER OF COMMERCE.

That a fiscal duty of $3\frac{1}{2}$ per cent on yarn, and 5 per cent. on cloth, is now levied in India on the importation of British cotton manufactures, assessed on tariff rates fixed many years ago, when values ruled much higher than they do now.

That the tax is now found to be absolutely prohibitory to the trade in yarn and cloth of the coarse and low-priced sorts.

That a protected trade in cotton manufacture is now consequently springing up in British India, and an unsound commerce is being fostered in that country which will, sooner or later, cause embarrassment and distress to the native capitalists and workmen.

The protective duty stimulates the erection of cotton factories in India. It defeats the primary object of the tax as a source of revenue, by encouraging the production of goods in India.

That the said duties are increasing the cost to the native population —or at least to the poorest of the people—of their articles of clothing, and thereby interfering with the health, comfort, and general well-being of the Queen's Indian subjects.

DEPUTATION FROM MANCHESTER TO THE SECRETARY OF STATE FOR INDIA.

The Marquis of Salisbury received a deputation from the Manchester Chamber of Commerce, who waited for the purpose of submitting reasons for the abolition of the duties imposed on cotton goods imported to India.

Mr. Lord said—The first mills in India for the manufacture of cotton goods were built in 1854, in which year two mills were erected in the island of Bombay. In 1873 there were at work in Bombay 15 mills, and they produced that year 29,000,000 lbs. of yarn and cloth; in Mofussil five mills, of small size, and he would put their production at 1,700,000 lbs. There were now nearly erected twelve new mills in the island of Bombay and in Mofussil, which together would probably produce another million His brother, who lived at Bombay, had sent him a list containing details of the dividends of several of the best mills, which had been just declared, and they ran from 15 to 20 per cent. In India they used exclusively Surat cotton,

while the English manufacturers used only one-fourth of it, the mixing must be very much more costly, so they must compete with Indian manufacturers at a disadvantage At present about £2,000,000 sterling worth of goods was produced in India by steam power, and the mills now being erected would make that £3,000,000 The English spinner and manufacturer had of course to lose that trade, but he still retained a trade equal to about £15,000,000 per annum. The tendency at present was to draw away capital and labour from the culture of the land. It would be a great benefit to the poor and heavily taxed population of India to be relieved from an impost of 5 per cent. on their clothing. He trusted the arguments that he had adduced would receive the earnest attention of his Lordship, with a view to the abolition of the impost, and so enabling the English manufacturer to compete on equal terms with the producer in India, both being fellow-subjects of the queen.

Mr. Ross submitted figures to show that a spinner buying Surat cotton in Liverpool, or through an agent in Bombay, and sending his yarn there, would be at a disadvantage, as compared with a Bombay spinner, equal to 26·10 on the selling value in Bombay.

REPLY BY LORD SALISBURY.

The principles of free trade had been accepted for a very considerable time. . . . . As to the effect of the tax as a protective duty, he was very sceptical as to this duty having much effect in nourishing competition.

The import of cotton goods was steadily increasing. The return for 1872-3 was 17,234,000 lbs.; so the importation of cotton goods into India could not be said to show signs of falling off.

They had heard that 25 per cent. was the handicap under which they ran this race. That was the disadvantage against which they had to contend In India there was the raw material and the labour, which was cheaper, and as regarded all delicate manipulations of the hand more skilful. There appeared to be nothing wanting except the coal and the capital. Well, he had just received papers which showed that the great coalfield which was close to the cotton might be calculated to yield 17,000,000 of tons at a depth of between 170 and 200 feet from the surface If that was found to be correct, there would be nothing but capital wanted to establish flourishing manufactories. He thought, therefore, that they must admit the possibility of a stiff competition for the supply of the Indian market.

It was hardly fair to the Indian Government to lay upon its financial policy the burden of those disadvantages which really came from a natural state of things

The Government did not look upon this as a permanent source of their revenue. They would be very glad if they could get rid of it. He did not say that it stood first on the list for reform, because there were international custom-houses which sinned more largely and flagrantly against economical laws than even protective duties, but they were anxious, whenever their financial position should enable them to do so, to see this duty disappear.—(Extracts from *Manchester Guardian*, 5th November, 1874.)

SIZE IN MANCHESTER CLOTH.

(Report of the Directors of the Manchester Chamber of Commerce)

That the excessive sizing of cloth, for the object of producing weight and cheapness, is dangerous, and considerably increases the risk of the generation of mildew

That the artificial introduction of moisture into the yarn of cloth, for the purpose of increasing weight, during the processes and stages of manufacture, or after manufacture, or the deliberate moistening of the cloth by means of damp storage, tends to create mildew, and must be condemned. . . . It has undoubtedly increased in magnitude and become more serious in character of late years, and the chief causes have been intense competition and the demand for low-priced goods.

Signed by the members of the Committee, Chamber of Commerce, Manchester, April 21, 1873—Hugh Mason, president; John Slagg, Jun., director; George Lord, director, Sam. Mendel, J Nicol Fleming, Joseph Thompson, J. Garnett, Adam Dugdale, Richard Bolton (R Holroyd and Co.), and Peter Spence

DISCUSSION AT THE EAST INDIA ASSOCIATION.

Mr. C. Meenacshaya said—To ask India to do without protection, and to enter into open competition with England, was just like asking a child to stand up and fight with a grown-up man

The arguments generally advanced against a protective duty are reducible to two First, that a protective system compels the poorer population to pay a larger sum for their clothing than otherwise would be the case. Secondly, that it is an artificial propping up of an industry which will fall to the ground when the support is removed, leaving it weaker than before. As regards the first difficulty, the difference in price would be of so slight a character that it would be of little importance when we consider the future advantage which will accrue to the nation when its manufactures have been fully developed Then, as a mercantile matter, we must consider the enormous amount of swindling which goes on now in the way of "filling in" the Manchester cloths, and how, under this disguise, what flimsy material is sent to the natives of India , so that, if even twice as much were paid for strong native cloth, it would be a real gain.

As regards the second objection, it was certain that there must be some nursing of industry in order to induce a strong and healthy growth. Were India an independent country, and the political connection between England and India non-existent, who could doubt that a wise and sagacious ruler in India would encourage by every means, artificial or natural, the establishment of native industries?

Mr. Dickinson said—Hardly any one in these days would deny that the development of manufacturing industries was an effectual method of sustaining a population, and of creating national wealth. It did not follow that a country should entirely depend on manufactures ; it might depend partly on manufactures and partly on agriculture; but, at any rate, the former formed one of the great resources of a progressive country. Now in India it was a fact, which seemed to have

been forgotten, that many important manufactures formerly were carried on with success, and some of these were even exported to England. Such things as Madras sheetings were well-known articles of commerce, and the way in which those industries was destroyed was by a most cruel system in the English manufacturers' interest By means of duties at the ports and duties in transit, the native manufactures were utterly crushed out.

It was clear to his mind that a slight protective duty would turn the scale in favour of the Indian manufacturer, and by showing a profit on native manufactures, capital would be induced to flow into India not alone from Manchester, but from all parts of the world.

Protective duties would give native manufactures a start, and that once done, they would soon be able to go on without external assistance, for the people had great natural aptitude, the raw materials for their labour were on the spot, and, under proper training, native ingenuity might be trusted for the rest.

Mr. Elliott (coffee planter, Mysore) stated that India, with all her people thrust on the soil for their sole means of support, is exactly in the position that Ireland was before the famine—that while the leaders of these impoverished masses have no share of political power, they have caught from us the spirit of inquiry—that the people are so poor that, from sheer want of adequate purchasing power, they are liable to famine—that, with the exception of lands irrigated by muddy river water, the people of India, in consequence of the small manuring facilities at their command, are not living on the interest, but on the capital of the soil These are facts. . . .

Not only have the capabilities of the country for mill-work been already proved by the success of the existing mills, but we are able to point to spots where cotton and water-power can be found within easy reach of each other Imagine British trade and manufactures—English manufactures with English capital—firmly planted on that vast central peninsula, and is it not evident to any one that we should then command the Eastern as completely as we now do the Western hemisphere? How often has Manchester capital and energy sought a wider field! Here at last, if we could only educate her into seeing it, it lies clearly before her. . . .

Compel your Manchester men to send some of their capital and younger sons to India, to do there what younger sons have done in our numerous colonies, by the simple process of imposing a gradually increasing import duty on Manchester goods, with the distinctly declared intention of raising it ultimately to a prohibitive tariff, to the end that India may not only be turned into a manufacturing country for itself, but, in a great measure, for all Asia and Eastern Africa.

NOTE ON COTTON MANUFACTURES.

The consumption of raw cotton at present in Great Britain is 63,000 bales per week; about 33,000 American, 15,000 East Indian, and 17,000 of other countries

The proportion of consumption in Great Britain is 48 per cent., on the Continent, 32; in the United States, 20, total, 100 per cent.

The number of spindles in Great Britain is about 40 millions, on the Continent, 20 millions.

The consumption per spindle of cotton in Great Britain is 33 lbs; on the Continent, 43 lbs. per annum.

The export of piece-goods in 1873 was, from Great Britain—

To India	112 million yards.
To China	84 " "
To all countries . .	3,482 " "
Yarn . . .	214 million lbs.

In Great Britain, in 1873—

Cotton consumed was . .	1,246 million lbs.
Less waste in spinning	168 " "
Yarn produced	1,077 " "
Exported in yarn	215 " "
" in piece-goods . . .	689 " "
Home consumption	173 " "
Total production	1,077 " "

The value of production was—

Yarn exported	£16,000,000.
Goods exported	68,000,000.
Home consumption . . .	20,000,000.
Total value	104,000,000.
Cost of cotton . . .	45,000,000.
Leaving profit, wages, &c. .	59,000,000.

—(From Ellison and Co.'s *Liverpool Circular* for 1873.)

TRANSIT DUTY ON SUGAR IN INDIA.

Rate of duty on unrefined and refined sugar, per maund, passing from one British province to another—

Year.	Refined	Unrefined.
1844-60	8 annas	3 annas.
1860-61	8 as. and 1 rupee	3 as. and 6 annas.
1861-70	1 rupee	6 annas

AMOUNT OF TRANSIT DUTY COLLECTED ON SUGAR

At the Ports of Dhuggar, Bundee, Dhassa, and Gurhi-Harsoo—

Year.	Refined. Rs.	Unrefined Rs.	Total Rs.
1865-66 . .	1,11,035	2,05,097	3,16,132
1866-67 .	96,779	1,81,720	2,78,500
1867-68	1,13,680	1,84,624	2,98,304
1868-69 . .	76,052	1,72,836	2,48,888
Total .	3,97,547	7,44,278	11,41,826

(Signed) W. W. Wright,
Collector of Customs.

Delhi, 13th April, 1869.

A FINANCE MINISTER'S MISTAKE.

(Examination of Mr. Massey, M.P., late Finance Minister i India, 16th July, 1872, before the Parliamentary Select Committee East India Finance.)

Question 8786.—Sir D. Wedderburn: With regard to th(transit duties of which we were speaking, is it not the case tl there is a transit duty on sugar passing from Upper India, ii Rajpootana ; I mean that we impose one?

Answer.—We impose no transit duties whatever, that I am aware —(Minutes of Evidence, vol. ii., p. 474.)

OPINION OF THE GOVERNMENT OF INDIA.

(Despatch, April, 1870.)

If such a Department of Agriculture had existed, we doubt whet the export duties which we now levy on some of the main staples agricultural produce, and even on articles of Indian manufactu could have been imposed or maintained. If such a department l existed, it could never have tolerated the continuance of duties such those which are still levied on sugar exported from the North-West Provinces across the inland customs line. These duties are tra duties of the worst description, levied on one of the most import articles of the agricultural produce of Northern India.

DEPARTMENT OF AGRICULTURE, AMERICA.

Be it enacted by the Senate and House of Representatives of United States of America in Congress assembled, That there hereby established at the seat of government of the United State Department of Agriculture, the general designs and duties of wh shall be to acquire and to diffuse among the people of the Uni States useful information on subjects connected with agriculture the most general and comprehensive sense of that word, and to p cure, propagate, and distribute among the people new and valua seeds and plants.

Sec. 2. And be it further enacted, That there shall be appointed the President, by and with the advice and consent of the Senat "Commissioner of Agriculture," who shall be the chief execu officer of the Department of Agriculture, and who shall receive his compensation a salary of three thousand dollars per annum.

Sec. 3. And be it further enacted, That it shall be the duty of Commissioner of Agriculture to acquire and preserve in his dep ment all information concerning agriculture which he can obtain means of books and correspondence, and by practical and scien experiments (accurate records of which experiments shall be kep his office), by the collection of statistics, and by any other approp means within his power; to collect, as he may be able, new and v able seeds and plants; to test, by cultivation, the value of suc them as may require such tests; to propagate such as may be wo of propagation, and to distribute them among agriculturists.

shall direct and superintend the expenditure of all money appropriated by Congress to the department, and render accounts thereof, and also of all money heretofore appropriated for agriculture and remaining unexpended.

Sec 4. And be it further enacted that the Commissioner of Agriculture shall appoint a chief clerk, with a salary of two thousand dollars, who in all cases during the necessary absence of the Commissioner, or when the said principal office shall become vacant, shall perform the duties of commissioner, and he shall appoint such other *employés* as Congress may from time to time provide, including chemists, botanists, entomologists, and other persons skilled in the natural sciences pertaining to agriculture. And the said commissioner, and every other person to be appointed in the said department, shall, before he enters upon the duties of his office or appointment, make oath or affirmation truly and faithfully to execute the trust committed to him. And the said commissioner and the chief clerk shall also, before entering upon their duties, severally give bonds with sureties to the Treasurer of the United States, the former in the sum of ten thousand dollars, and the latter in the sum of five thousand dollars, conditional, to render a true and faithful account to him or his successor in office, quarter-yearly accounts of all moneys which shall be by them received by virtue of the said office, with sureties to be approved as sufficient by the Solicitor of the Treasury, which bonds shall be filed in the office of the First Comptroller of the Treasury, to be by him put in suit upon any breach of the conditions thereof.

May 15, 1862.

THE END.

THE

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FOR THE

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Although some of the Princes and other Natives of Western India have of late accorded to the Association a liberal pecuniary support, yet its income falls considerably short of that necessary to place it on a permanent footing, and increase its sphere of usefulness.

It is hoped, therefore, that Members will individually aid the Council in this respect, by means of donations, presents of books for the increase of the Library, &c.

Resident Members are furnished with Blank Tickets of Admission to the Lectures for the use of their friends.

Indian, English, and Vernacular Newspapers are received and filed in the Reading-room of the Association, in addition to the leading Daily Papers of the Metropolis, and several Weeklies

The use of the Reading-room and Library is free to Members who can also have their letters addressed there.

The Secretary will be happy to forward Application Papers, Rules, &c., or give any other information desired.

HOW TO DEVELOPE

PRODUCTIVE INDUSTRY IN INDIA

AND THE EAST.

MILLS AND FACTORIES

FOR

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WITH

ESTIMATES AND PLANS OF FACTORIES.

EDITED BY P. R. COLA,

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1867.

OPINIONS OF THE LONDON PRESS.

From the "Daily Telegraph"

"How to Develope Productive Industry in India," edited by P R Cola, and illustrated by numerous and excellent woodcuts, is a book not to get from a circulating library, but to buy, study, and then possess for future reference. . . . It gives a complete account of the past and present position of the East in regard to manufactures, and brings forward trustworthy data for judging what may be its future, if modern enterprise and capital can only be induced to try fresh fields and pastures new.

From the "Engineering."

This is a volume advocating the extension of European modes of manufacture to India and other countries of the East, and containing plans and estimates of factories . . The day, we believe, will come when factories of the kind Mr Cola describes will take wide root in India, and it would be a miserable and unworthy policy in us to discourage their establishment . . . Mr Cola has performed a useful service by affording so much information about the cost and arrangements of so small factories suited for such a country as India, and such details will be specially useful to those who meditate the establishment of factories in that country. . .

From the "London Mechanics' Magazine."

Mr. Cola in all cases has adapted his plans of mills and factories to the peculiar requirements of the country, and has based his estimates in many instances upon actual invoices, whilst in others his information comes from the manufacturing districts. . . . But what he does profess to do, and what he really does in a most efficient manner, is to give capitalists, commercial men, and manufacturers an excellent industrial guide-book, applicable, not only to India and the East, but to other countries. The general reader, too, will find much to interest him in the introductory chapter, by which each section is preceded We hope his book will be as successful in developing the productive industry of India as he has been in showing how it may be accomplished.

From the "Home News"

"How to Develope Productive Industry in India and the East." This is a large subject, but it is treated in a large spirit, in a work just published and edited by Mr. P. R Cola, who was lately the sole proprietor of the Arkwright Cotton Mills, at Bombay. . . . He shows the practicability of all such undertakings . . . Unlike most other writers on these subjects, Mr Cola furnishes plans and estimates of the cost for the several descriptions of works. . Great praise is due to the care and industry which has collected and collated these materials.

From the "Illustrated London News."

There can be no question about the importance of the subject treated of in this volume, or about the fitness of the editor, if experience be

any test of fitness, for the task he has undertaken. . . . The information collected from various sources could not have been gathered together without consideraule trouble.

OPINIONS OF THE INDIAN PRESS.

From the "Bombay Builder."

This work brings within the compass of a single volume much important information on a variety of subjects connected with reproductive commercial industry. . . . If any man can be found who should do for agriculture what Mr. Cola has endeavoured to do for manufacture, he would deserve well of the people of India. . . . Passing, however, to the immediate object of Mr. Cola's book, we offer the author our hearty congratulations on what he has achieved. His has been a work of vast labour: to obtain, compile, arrange, and set forth the various manufacturing processes described in the book has been by no means an easy task. . . . He has succeeded very admirably in his undertaking. As a preliminary work of reference for those who may desire to establish steam factories in India for the purpose of manufacture, the book will be found a useful guide.

From the "Friend of India."

The question of the development of productive industry in India has been often discussed, but beyond this discussion little progress has been made. . . . This exhaustive work by Mr. P. R. Cola does justice to the question. . . . He goes fully and systematically into the various branches of industry, and discusses every point connected with each. He takes a very hopeful view of the industrial future of the East, and by a judicious arrangement of facts and statistics commands attention and deference to his pleas. . . .

From the "Indian Mirror."

There breathes in the whole work a spirit of good feeling and a real interest in the cause of India and the East. No pains have been spared to render it a work of as much practical utility as is possible in so short a compass, so as to prove, as the author himself says, "a useful industrial hand-book." . . . It is believed and earnestly hoped that the remarks on the facilities and advantages of introducing improved machinery in some of the manufactures for articles of daily and extensive consumption, as set forth in the work under notice, will not be lost upon our wealthy countrymen.

From the "Native Opinion."

Our system of education talks learnedly of awakening "an intellectual and vital soul in the nation;" but we may well question the utility and value of the so-called awakening when we find it taking no cognisance whatever of the development of the material resources of the country. . . . The book is written in a neat, business-like style and is entirely free from attempts at essay writing.